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PERSONALITY [illegible]

BY

LAWRENCE [illegible]

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A THESIS

SUBMITTED TO THE FACULTY OF GRADUATE STUDIES

IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE

OF DOCTOR OF PHILOSOPHY

DEPARTMENT OF EDUCATIONAL PSYCHOLOGY

EDMONTON, ALBERTA

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THE UNIVERSITY OF ALBERTA

PERSONALITY FACTORS IN MATHEMATICS LEARNING

BY

LAWRENCE JOHN TOMKO

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SUBMITTED TO THE FACULTY OF GRADUATE STUDIES
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The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies for acceptance, a thesis entitled "Personality Factors in Mathematics Learning" submitted by Lawrence John Tomko in partial fulfilment of the requirements for the degree of Master of Education.

ABSTRACT

One of the aims of this study was to investigate and identify the personality dimensions believed to be associated with achievement, attitude and sex in mathematics learning at the grade eight level. Another purpose was to determine whether or not a better prediction of mathematics achievement, beyond general intelligence, could be found by the use of attitude-to-mathematics and personality scales. In addition it was an aim to determine whether significant prediction of attitude could be gained by using personality and achievement scores.

The study was designed to compare six personality traits: Dominance, Sociability, Self-Control, Communality, Flexibility, and Femininity for levels of achievement, attitude and for sex. One attitude-to-mathematics scale, six scales of the California Psychological Inventory and two modern mathematics achievement tests, each at a different taxonomic level, were administered. Correlations were computed to determine the relationship among the variables. Three-Way Analysis of Variance was used to compare levels of the variables and to analyze the interaction effects. Stepwise Regression Analysis was used to indicate, in addition to intelligence, the personality traits that are associated with mathematics learning.

It was found that significant differences in mean

personality trait scores existed among levels of achievement and attitude, and that several of the personality traits contributed, over and above general intelligence, to achievement in mathematics. Achievement and Self-control were the largest contributors to prediction of attitude. The Communality and Flexibility scales also contributed significantly to prediction of attitude. Sex differences were associated with personality differences which, combined with the above findings, led to a number of potentially useful implications for mathematics education.

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CHAPTER I

THE NATURE AND SIGNIFICANCE OF THE PROBLEM

I. INTRODUCTION

The significance of mathematics as a necessary tool in everyday living as well as in numerous occupations is readily observed. There have been many and varied changes in mathematics to keep up with the technological demands (Brown, 1961). Meder (1964) points out that of all the mathematics known today, more than half has been discovered in the last fifty years. It appears more people need mathematics than ever before in history, yet mathematics has been labelled dull, routine, incomprehensible, too abstract, and non-utilitarian. Consequently most students are scared away after one or two years of high school mathematics (Versely, 1963).

Gough (1954) defined this fear of mathematics as "mathemaphobia". To find the causes of this fear and extreme adverse attitude to mathematics is of first importance to her:

> Why not a foundation like the heart and cancer foundation to study the causes and cure of mathemaphobia? Is the mental balance and stability of students of less importance than their physical well-being?[1]

---

[1] Sister Mary Fides, C.P. Gough, "Mathemaphobia: Causes and Treatments," Clearing House, 28:294, January, 1954.

Gough (1954) revealed that often the problem is rooted in the personality of the child and in the effects of teachers, peers, parents, successes, failures, and materials. These may impinge on different personalities in different ways possibly producing different attitudes, sometimes extreme anxiety and thus adverse attitudes, even when the students' aptitude matches that of other students.

Tulock (1957) mentioned that there is convincing evidence that far fewer students are studying mathematics every year. Even with new large scale modern mathematics programs attitudes toward mathematics have not changed (Remai, 1965). Study of the emotional fear of mathematics is one direction for research since it could be a possibility that each student according to his or her personality is affected to a different extent. Within Tulock's (1957) realm of experience she saw "some pupils ... so tense after traumatic experiences they seemed simply paralyzed. So rigid was the set against mathematics that some were convinced that they just could not learn mathematics."[2] Biggs (1959) stated that the general public realized that the greatest problem in teaching mathematics is to overcome the fear or anxiety the subject has instilled in the students' mind. There is a factor of intelligence which is directly related to performance

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[2] Mary K. Tulock, "Emotional Blocks in Mathematics," The Mathematics Teacher, 50:572, December, 1957.

in mathematics, however, there is the other factor sometimes called the "emotional component" as Biggs reveals:

> (Besides general intelligence accounting for much of the variance in test scores there is) the affective aspects of mathematical ability, or the "emotional component", as some investigators call it. This may also be complex and made up of different kinds of factors. On the one hand, it seems that certain types of personality are better suited to mathematical study than others: emotional instability and anxiety have been shown to affect adversely performance in mathematics, as that subject is at present taught, to a relatively greater extent than performance in other subjects. This aspect may be called a primary factor of emotionality in mathematics, as opposed to the secondary or derived factors which are specific to mathematics and which are not necessarily part of the basic personality pattern. These secondary factors are of course, the attitudes displayed by children and adults towards arithmetic and mathematics -- the negative ones varying from a simple distaste to what amounts to a veritable phobia. It scarcely needs pointing out, however, that these attitudes may tend to take root more easily in the unstable personality.[3]

The need for research which involves a study of the influence of personality as it affects learning of mathematics is shown where personal adjustment, sociability, and other personality variables have led Plank (1950) to place personality as a prime factor in the learning of arithmetic.

Recent years have seen tremendous changes in the mathematics curriculum and the interaction with different personalities probably results in different achievement and attitudes. In analyzing the students one must ask the basic

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[3] J.B. Biggs, "Attitudes to Arithmetic - Number Anxiety," Educational Research I, 3:7, June, 1959.

question from which other questions would likely stem: are achievement and attitude related to personality? This question and other important related questions need to be asked, and answered if in the future materials and programs are to be developed taking into account the students' personality. Under our present system is there a relationship between the selected personality traits and achievement as well as attitude within a certain ability range? The answers for this would provide a basis for future studies which would investigate the problem of whether the same ends or poles of the same personality dimensions are associated with achievement and attitude under a different setting such as the experimental schools.

II. STATEMENT AND DISCUSSION OF THE PROBLEM

The purpose of this study was mainly twofold. The first purpose was to determine the relevance of personality in mathematics learning. The relationship was sought among the variables: personality (using six selected dimensions), achievement in mathematics, attitude to mathematics and sex. Since grouping or categorization of students into levels of achievement is still a necessary administrative task, knowledge of the personality patterns within groups and between groups would likely be of value to those persons associated with mathematics learning. The second purpose of this study was to determine whether or not selected personality traits

were important prerequisites for mathematics learning. Therefore an attempt was made to assess their importance in predicting mathematics performance as well as attitude to mathematics.

The writer hypothesized that the following personality scales are related to achievement in mathematics as well as to the students' expressed attitude to mathematics: Self-Control (Sc), Dominance (Do), Sociability (Sy), Communality (Cm), Flexibility (Fx), Femininity (Fe).

The relevance of personality in mathematics learning has been analyzed in the literature. The literature which is discussed below indicates that some personality factors correlated with achievement almost as highly as did general intelligence. Causes of attitude to mathematics were mainly analyzed through the following possibilities: (1) Success or failure in mathematics; (2) Parental encouragement to study mathematics; (3) Analysis of previous mathematics teachers; and (4) Personality variables.

Since the studies discussed below generally show that socio-economic status is directly linked to general achievement, the socio-economic factor appeared very relevant to the analysis of mathematics learning.

Within the literature a study by Ames (1943) showed that when achievement and intelligence were analyzed, intelligence correlated highly with academic work. However, personality factors such as dependability, common sense, and

persistence correlated almost as highly with achievement as did intelligence. Low neurosis, high self-sufficiency and high dominance were found by Stagner (1932) to contribute to achievement almost to the same degree as did intelligence. Neale (1969) found achievement in mathematics linked with submissiveness (low scores on a Dominance scale) and desire to show self-control.

The explanation of attitude to mathematics has been approached in previous research from mainly three angles. Success or failure has been offered as an explanation for high positive attitude and high negative attitude, respectively (Billigs, 1955; Kurtz and Swenson, 1951; Dutton, 1954; Bendig and Hughes, 1954; Dutton, 1956; Tulock, 1957; Stephens, 1960; Carnett, 1967; Price, 1967). The relationship of parental encouragement and experience with previous teachers to attitudes to mathematics as well as to performance has been analyzed (Dutton, 1954; Aiken and Dreger, 1961; Michael and Cryan, 1951; Tibbetts, 1955; Biggs, 1959; Poffenberger and Norton, 1959). Important discoveries in differences in mathematical performance particularly in problem solving have led researchers to consider personality variables as a basis for differences in attitudes towards mathematics (Ames, 1943; Plank, 1950; Dreger and Aiken, 1957; Milton, 1957; Carey, 1958; Biggs, 1959; Aiken, 1963; Neale, 1969).

Success-failure studies do not account for the fact that when I.Q. is held constant in a narrow range and the

successful high-achieving students are analyzed, one still finds a significant difference in attitude to mathematics (Stephen, 1960; Aiken, 1963). Analysis of previous teachers has its main failing in the students' inability to recall specific aspects of the teachers' personalities (Poffenberger and Norton, 1959; Aiken and Dreger, 1961). Either a few exceptionally good points or the traumatic experiences with the teachers are the only memories the student relates to mathematics and arithmetic of earlier years. Other related factors are usually forgotten (Dutton, 1954; Gough, 1954; Tulock, 1957). As a result of the failings in these approaches and significant findings in certain aspects of personality studies as explanation of attitudes (Milton, 1957; Carey, 1958, Aiken, 1963; Neale, 1969), the direction involving personality traits appeared most fruitful.

Aiken (1963) found all fifteen out of fifteen carefully chosen personality variables correlated with an attitude-to-mathematics scale. He stated that the results were "too numerous and too internally consistent to be spurious".[4] Plank (1950) found negative attitudes to arithmetic related to problems of personal adjustment. Anxiety studies showed that some types of personality were better suited for mathematical study than others (Biggs, 1959; Dreger and Aiken, 1957). Burgess (1956) reported a

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[4] Lewis R. Aiken, "Personality Correlates of Attitude Toward Mathematics," *The Journal of Educational Research*, 56:479, May, 1963.

set of personality scales which were linked to attitude. These were adaptability (or flexibility), cautiousness, and control of emotional reactions (or self-control) as well as less sociability. One of the important findings that offer personality variables as an explanation of attitude differences was perceived by Carey (1958) and Milton (1957). Milton showed masculine men and masculine women were both better problem solvers than either feminine men or feminine women.

Socio-economic levels could not be ignored in a study of this nature. Personality maladjustment was indicated by Engle (1934) in children from both underprivileged homes and privileged homes as these presented more disciplinary problems than children selected at random. Suppression or enhancement of personalities ordinarily destined for academic work was found by Reeder (1955), where inferior homes tended to retard while superior homes tended to accelerate the progress of children through the schools. It appeared important, therefore, to select students accordingly, excluding the extremely high or low in socio-economic status so that socio-economic status would not become a separate factor, with its various possible levels, in this study.

III. SIGNIFICANCE OF THE PROBLEM

In the education of the child the main objective to keep in mind is that we are attempting to educate each child to his maximum potential in order to prepare him for a full

and useful life in our society (Fisher, 1964; Taba, 1962). In order to educate a person one should know the way a person consistently responds to others and to the environment especially in this case mathematics.

The teacher, upon realizing that certain attributes of the students' personality are adverse to learning mathematics, could use his creativity and perhaps apply other related research in teaching a child according to what method suits both personalities.

The parents and the school counselor probably would be exceptionally interested in studying the child's personality as it affects the child's attitude to mathematics and his performance. Perhaps upon predicting failure earlier in the child's life, more could be done by the home and school to prevent its actual happening.

The school administrators and mathematics supervisors with the aid of school psychologists would be able to select materials from book companies demonstrated to be suited for the personality type and hence develop optimum programs for the students. One of the essential places results of this study are required is in mathematics textbook development. Students learn differently according to their intelligence and by the way they consistently respond to the school environment which includes textbooks in the school situation.

In general, most people in any aspect of teaching mathematics would like to know what makes students afraid of

mathematics especially when many of these students make good grades in other subjects.

IV. LIMITATIONS

Several limitations exist due to the conditions and circumstances under which the study was conducted. These will now be pointed out.

The treatment which may be defined generally as the traditional teacher-taught atmosphere, is very difficult to define precisely because of the wide variety of procedures that can be used within the classroom. However, in general, an intuitive grasp of this treatment can be obtained since in most of the classrooms, a teacher, one or two mathematics textbooks, and a session of instruction with seat-work is the type of activity that prevails.

In research work it is often a difficult task to draw large random samples to obtain an extended degree of generalization. Since the sample in this study was not very large, the conclusions and therefore the interpretations should be viewed with caution.

It was found that in the six grade eight classes tested there were not sufficient students to do an analysis of sufficient depth using the Three-Way Analysis of Variance method for other than the levels given below. Intelligence ranges, from one hundred and ten to one hundred and twenty I.Q. points and also from ninety-five to one hundred and nine

I.Q. points were analyzed. Studies using the Analysis of Variance method for intelligence levels other than these would also prove of interest. However, by means of correlations, other intelligence levels were analyzed.

The final limitation is the use of the Blishen scale to measure socio-economic status. Because this is a national scale, Blishen cautions its use in specific localities. Since Edmonton is large it appeared that no single minority group would be used in this study. Hence this scale appeared acceptable to use.

V. CLARIFICATION OF TERMS

Several of the terms which the reader might require clarification on are defined as follows:

Achievement in Mathematics will mean the mathematics scores the students obtained on two specially designed tests.

Attitude to Mathematics is defined as a composition of intellectual appreciation of mathematics and emotional reactions to it. This composition is inferred by the student's response to situations symbolically represented and measured by an attitude-to-mathematics scale.

Personality is defined as a cluster of interrelated traits largely acquired through socialization. These traits result in consistent ways of responding to others as well as to the environment and are assumed measurable by means of a personality inventory.

Socio-economic status is defined as a score designating social class level and is based on Blishen's (1967) scale entitled "*A Socio-Economic Index for Occupations in Canada*".

VI. PREVIEW OF THE THESIS

Chapter I introduces the problem and shows its relevance within the educational scene. Limitations and the definitions of terms are also included. A review of the significant literature is contained in Chapter II. Chapter III consists of a description of the instruments used. Chapter IV contains the design of the experiment and statistical procedures to be used. Chapter V contains the data and analysis of results. The conclusions, interpretations, and implications for further research are included in Chapter VI.

CHAPTER II

REVIEW OF THE RELATED LITERATURE

I. INTRODUCTION

The related literature can basically be analyzed within four categories. These four categories include studies on achievement, attitude, sex and socio-economic status. The attitude studies were further organized around three basic approaches: (a) success-failure, (b) parental expectation and teacher effect, and (c) personality.

II. ACHIEVEMENT STUDIES

Ames' (1943) study attempted to demonstrate that personality traits may be related to achievement. She found that intelligence alone does not account for all variation in scholastic achievement. In her study of three graduating classes of a midwestern high school she found a range of twelve to fifteen per cent of students achieving grades above the class average while at the same time possessing I.Q.'s below the class average. This evidence suggested other factors besides intelligence are involved in academic success. To determine what personality factors together with I.Q. could be used in prediction of scholastic success she administered A Trait Personality Rating Scale and

A Thirteen Item General Attitude Toward School Scale. Sociability, attractiveness and popularity were three traits which showed no significant correlation with scholastic achievement. Four traits, namely sociability, attractiveness, popularity and courtesy had no significant correlation with intelligence. On the other hand persistence, common sense, and dependability correlated with achievement about as highly as did intelligence. Punctuality, cooperation, honesty and sincerity each had significant correlations with achievement. It is interesting to note that none of the thirteen traits correlated significantly with the Otis score. When she used the traits with the highest three Beta weights she obtained a multiple correlation R of .71 as compared with .72 using all thirteen variables. Ames showed that predicting scholastic achievement from an Otis score alone the zero-order correlation was only .54, but for predicting scholastic success from the Otis scores plus ratings on persistence and attitude toward school the R was .71. It appears that personality traits do correlate with scholastic achievement at the high school level and better predictions of achievement can be made by using personality ratings plus an intelligence score.

Using the Thurstone centroid method of multiple factor analysis the fifteen variables were shown to measure two factors: ability to succeed socially, which had no relation to high school achievement; and tendency to conform

to the school situation, which correlated highly with achievement. Persistence and attitude toward school carried most of the weight when predicting achievement.

Similar results as the above were obtained by Kurtz and Swenson (1951) and Aiken and Dreger (1961) when tests of significance were applied to the ratings on achievement and attitude toward educational achievement. These attitudes were more closely related to achievement than they were to intelligence as defined by the Otis Intelligence Test.

Stagner (1932) saw that attitude governed the industry and application of the student to his task, and in considering the relation of personality traits to academic aptitude and achievement he found that low neurosis, high self-sufficiency, and high dominance contributed to achievement almost to the same degree as did intelligence. The data show that a substantial difference in aptitude may be nullified by differences in personality. The high intelligence group were ten percentile points above the lower one on intelligence test scores but on achievement they differed by only .01 grade points. Similarly the group scoring low on the dominance scale had a difference in percentiles of 5.91 on the aptitude scale from the group high in dominance, but the latter were only .07 grade points behind the former on achievement. Similar results as for dominance were found for self-sufficiency.

Frankel (1960) in studying achieving and underachieving students analyzed fifty high school boys of high intellectual ability. On their reaction to school subjects the overachievers ranked mathematics as the easiest, and mathematics and science as the best liked, English as the most difficult and least liked. The underachievers selected science as the easiest and best liked subject and foreign language as the most difficult and least liked. Significantly more overachievers than underachievers selected mathematics as the easiest and best liked subject, and English as the most difficult. In junior high school academic performance the two groups performed differently in terms of academic achievement. The overachievers performed higher academically and continued to do so but the underachievers continued to drop in marks. The difference between the means of these two groups as taken in high school was twice as great as the difference between the groups when they were in junior high. It appeared that explanation in terms of personality differences would be essential.

The question whether students who overachieve in a college situation have common personality factors which differentiate them from college students who underachieve was answered in the affirmative by Burgess (1956). She took samples of twenty college students obtained according to whether or not their actual scores were statistically close to their predicted scores. Those students with scores above

their predicted score were in one group called overachievers and the students whose scores were below the predicted scores were called underachievers. A battery of six tests was administered. The appropriate tests showed that overachievers tended to be more adaptable, cautious and have more intellectual control of emotional reactions, whereas the underachievers showed a significantly smaller score on each of these traits. This study also found that the *Minnesota Multiphasic Personality Inventory*, the *Bernreuter Personality Inventory*, the *Occupational Level and Interest Maturity Scales of the Strong Vocational Interest Blank for Men* and the *Rosensweig Picture Frustration Study* when given and scored in their usual form were not suitable for differentiating groups of academic deviates. Differentiation and the significant results reported above were results from scores from the *Projection Tests*. Bloomberg (1955) using different tests also found similar results.

III. ATTITUDE-TO-MATHEMATICS STUDIES

The literature related to attitude to mathematics can basically be analyzed within three categories since most research attempts to explain favorable or unfavorable attitudes to mathematics as a cause of: (1) previous success or failure in the subject area; (2) parental expectations and teacher effects; (3) the rooted personality variables. These studies stem from three basic assumptions with regard

to attitudes in general which Doob (1947), Chein (1948) and Rhine (1958) clarify: first, a person is not born with his attitudes; second, the learning process plays a major role in the development of attitudes; and third, all attitudes involve aspects of personality.

The type of attitude referred to here is described in detail in Chapter III.

Success-Failure Studies

Kurtz and Swenson (1951) found that success or failure were not directly related to intelligence when they selected their subjects as follows: high achievers of high ability called the high-high group for easy reference, medium achievers of medium ability called the medium-medium group, and low achievers of low ability called the low-low group. Also there were high achievers who were low in ability, named plus achievers and low achievers who were high in ability, named minus achievers. The resulting intelligence scores showed the high-high achievement group were high in intelligence but the plus achievers were low in intelligence. The medium-medium achievers were average in intelligence. Again a reversal showed where the minus achievers were high in intelligence. The low-low achievers were low in intelligence. Because certain students who are not very intelligent are able to develop skills and obtain the knowledge for successful school performance, this study tended to show

that a third factor must represent part of the factors which enable students to obtain favorable results. Kurtz and Swenson also found that the successful high-achievement group as well as the plus group were satisfied with the school situation. The remaining groups were the least satisfied. The minus group liked school the least. It appeared that the less successful the group at school the less favorable attitudes they possessed. This suggests that success might be related to attitudes. This study involved a total of two hundred students from grades four to twelve to which the _Otis Intelligence Test_ and the _Iowa Every-Pupil Test of Basic Skills_ were administered.

Success was found to be a major factor associated with attitudes to mathematics and arithmetic. Dutton (1956) found from the responses of 459 Junior High School pupils on an arithmetic attitude scale developed by him that eighty-seven per cent of the students enjoyed doing problems when they knew how to work them out. Dutton concluded that unfavorable attitudes to arithmetic by these Junior High students were due to failure or poor achievement as well as to lack of understanding and that favorable attitudes were partly due to the enjoyment received from solving problems successfully.

In a previous study Dutton (1954) investigated the responses of 289 students in various years, from junior through graduate, of the teaching program from which he found

thirty-nine per cent of these students did not feel sure of themselves in arithmetic. This feeling of possible failure showed up in other forms of the attitude scale where twenty-nine per cent of the students reported being afraid of doing word problems and sixteen per cent reported a fear of and avoidance if possible, of arithmetic. On the other hand, those having favorable attitudes to mathematics chose as their reasons that arithmetic was as important as any other subject (eighty-three percent); that they enjoyed the challenge of a problem (seventy-two per cent); and that they enjoyed doing problems when they knew how to work them out well (seventy per cent). It appeared that a favorable attitude to arithmetic was associated with a knowledge that success was imminent. The reliability of Dutton's twenty-two item attitude scale was determined by the test-retest procedure which gave a correlation of .94.

Bendig and Hughes (1954) constructed a thirty-item test to measure students' attitudes toward an introductory statistics course for students majoring in psychology and other related sciences. The test showed a reliability coefficient of .90 in a test-retest situation. They reported, where a student sample of seventy-one was used, that this test supports the general theory that students' attitudes determine to an appreciable extent their achievement. Out of fifteen variables only four correlated with the Statistics Course Attitude Scale. Three variables:

computational skill, amount of high school mathematics, and amount of college mathematics were positively and significantly correlated at the .01 level with favorable attitudes as measured by this scale. The fourth variable, the number of psychology courses, was negatively correlated with favorable attitude. This may mean, they state, that a forced exposure to a course with the possible severe consequences of failure may be the reason for the negative correlation. The investigators recommend that an instructor should work at removing the fears associated with various parts of a course.

Billig's (1944) attitude scale showed significant associations between successful arithmetic students and favorable attitudes as well as between lowest marks and antagonistic feelings. As a result Billig attempted to revise the work to a lower level for the students with unfavorable attitudes to allow them to experience success. Achieving the feelings of success was also attempted by directing the school work experience toward the students' intended life work.

The underlying assumption that students' success should be experienced at the students' level of ability is also found in Stephens' study (1960). She found that the accelerated group had significantly different attitude scores as found on the Dutton (1956) scale, than those in the regular groups. The attitude test was administered to 348 pupils at the seventh and eighth grade levels. However, there

were four students who had negative attitudes to arithmetic not explainable by success alone. Stephens suggests that those students not having a highly positive attitude toward arithmetic should not be put in accelerated classes. In addition, even though a student has high ability and achievement scores, the teacher should after counseling the student consider attitude as the placement factor. In the administration the instructions to the students were to think carefully about each statement as it was read to the class. However, according to Corcoran and Gibb (1961), in order to encourage spontaneous responses and thus obtain honest reactions rather than socially accepted responses, one should instruct the students not to think too long on a question. Therefore, the results of Stephens' study should be approached with caution.

Tulock (1957) develops this success-failure approach in the following quotation:

> ... We need men of confidence, courage, and skill. We do not increase mans' confidence by robbing him of his sense of accomplishment. No man has succeeded through constant failure. Pupils who constantly fail mathematics have deflated egos and tend to develop attitudes of dislike and hostility towards mathematics. They do not willingly enroll in algebra classes because they are afraid -- it represents a threat. People prefer success to failure. Why should they elect algebra? People tend to compete in a race only where there is a plausible chance of winning. They cannot fail -- if they choose not to run. Many sacrifice a doubtful victory to prevent a deflating defeat.[5]

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[5] Tulock, _op. cit._, p. 572.

She admits that lowering the standards is not the solution. Other possibilities include giving praise and success to the student while earnestly working for a deeper understanding of the mathematics at hand. Tulock relates fifteen methods for the development of the feeling of success.

Price (1967) designed a study in which mathematics was taught in three ways: by the discovery method, by the conventional method, and by a special method called the transfer method whereby students were shown the application of the concept to the real world. Each class was given, along with mathematical tests, an attitude questionnaire. He found that both the transfer and discovery groups showed a greater increase in mathematics reasoning than did the control group. These two successful groups, discovery and transfer, showed a positive attitude change toward mathematics, while the control group showed a negative change. The results suggested that mastery or success was closely tied to attitude and attitude change.

Carnett (1967), a representative of the Bureau of Research in Washington, D.C., reported the results of a global project where researchers administered the mathematical and attitude tests, among others, to approximately 130,000 students from over 5,000 schools in the twelve participating countries. It was found that students' attitudes do matter. High scores in mathematics were associated with

favorable attitudes, as well as a high regard for the place of mathematics in society. Participating in this five year study were Benjamin S. Bloom and C. Arnold Anderson, University of Chicago; and Arthur W. Foshay and Robert L. Thorndike of Teachers College, Columbia University.

Parental Expectations and Teacher Effects

Aiken and Dreger (1961) studied the effects on students of parental encouragement and parental attitudes towards mathematics. They found no evidence that attitudes to mathematics are related to parental encouragement to study mathematics. They obtained correlations between the non-intellective tests: the Mathematics Attitude Scale and the Intensive Personal Data Sheet (IPDS) for a sample of ninety-six males and eighty-seven females. With another section of the IPDS on parental attitudes towards mathematics, correlations were run and the results indicated there was no relation between students perception of their parents' attitudes to mathematics and their own attitude to mathematics.

Dutton (1954) in his analysis of reasons for liking arithmetic as given by 196 students from the University of California, found only six out of 406 responses indicated that encouragement from parents influenced their attitudes.

Poffenberger and Norton (1959) searched for evidence to support or reject the theory that basic attitudes toward mathematics would tend to develop within the home. They

developed a questionnaire with 140 items and studied a group of 390 high school students: fifty-two per cent were males and forty-eight per cent were females. (Over sixty-eight per cent attended high schools of 500 students or larger and almost half of the mothers and fathers had one or more years of college although twenty-nine per cent of the fathers and nineteen per cent of the mothers did not complete high school.) From this two groups were formed, one group which had a high positive attitude and another which had a high negative attitude toward mathematics. Of the favorable attitude group fifty-two per cent were males and forty-eight per cent were females; of the unfavorable attitude group thirty-six per cent were males and sixty-four per cent were females. There was no significant difference between the two groups regarding their parents' expectation in regard to school in general, but there was a significant difference in their expectations for mathematics. The students reporting favorable attitudes to mathematics were expected to perform as well in mathematics as in other subjects whereas fathers of students with unfavorable attitudes expected a lower mark in mathematics as compared to other subjects. Poffenberger and Norton reported a similar result for mothers. They recorded a significant difference at the .01 level between the two groups' perception of their fathers' liking of mathematics, and no significant difference between the perception of the mothers' attitude to mathematics.

Significant differences between the groups were found in the amount of parental encouragement. Thirty-eight per cent of the students liking mathematics reported their fathers strongly encouraged them to take mathematics courses, while thirty-two per cent of this pro-mathematics group said parents did nothing to encourage them to take mathematics. On the other hand twenty per cent of the anti-mathematics group were encouraged to take mathematics, while in the same anti-mathematics group sixty per cent of the fathers did nothing to encourage the taking of mathematics. The mothers' encouragement and attitude were similarly significantly related. In summary, there were significant differences at the .01 level between the pro-mathematics group and the anti-mathematics group on: the fathers' grade expectations, the mothers' grade expectation, the fathers' encouragement in mathematics, the mothers' encouragement in mathematics, the attitude of siblings to mathematics as well as the students' perception of their fathers' attitude to mathematics.

Tibbetts (1955) found:

> The high-achieving boys and parents were more nearly alike in expressing greater satisfaction with family relations than were the low achievers and parents in their generally less satisfactory characterizations of family behavior patterns.
>
> The comparative lack of agreement between parents on the standards of behavior expected of the boys is the most striking characteristic of the underachieving group. The high achievers identify themselves more closely with their families than do the low achievers, and are more

> likely to be motivated by a desire to please their parents. Concomitantly, the high achievers more often describe their parents as thoughtful, understanding, and interested. Relations between fathers and sons seem to depend on mutual interests and shared activities, while bonds between mothers and sons are based on mutual affection and trust.[6]

Tibbetts used the California Test of Mental Maturity as the aptitude score and scholarship was represented by the grade average of previous years academic subjects. The interview method was also used to obtain descriptions by boys, mothers, and fathers of the general family relationships, of the boys' attitudes and behavior, and of the parents' attitudes and behavior.

Aiken and Dreger (1961) in their experiment previously described, also reported that mathematics-attitudes are related to the recollection of former teachers. The females' attitudes were more affected by former teachers than the males'. There were more significant correlations for the females between the mathematics attitude scale scores and scores on items related to students' impressions of mathematics teachers and experiences with teachers. Correlations were significant between the scores on the rating

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[6] J.R. Tibbetts, "The Role of Parent-Child Relationships in the Achievement of High School Pupils: A Study of the Family Relationships Associated with Under-Achievement and High-Achievement of High School Pupils." Unpublished Ph. D. dissertation, New York, 1955. Reported in Dissertation Abstracts, 15:232, 1955.

scales of the IPDS (Intensive Personal Data Sheet) which referred to remembered characteristics of teachers, and the mathematics attitude scale scores. For males (the only significant correlation for males) and for females there was a significant positive correlation at the .05 level between positive attitudes toward mathematics and reported patience in previous mathematics teachers. For females other positive significant correlations between positive attitudes toward mathematics and certain personality traits of the teacher were found.

Poffenberger and Norton (1959), in the study already described, noted that most students had difficulty in recalling previous teachers. Their study based only on the recollection of one algebra teacher with whom the students were recently acquainted, showed that students who had a general dislike for mathematics disliked algebra in spite of the fact that they liked the teacher. Those who liked algebra liked the teacher as well. The study reveals no evidence to support the argument that students disliked mathematics because they were poorly taught. The students disliking mathematics in this study rated all mathematics teachers from grade school through high school much lower than did the group that liked mathematics. The researchers felt that the evidence from this study indicated that self-concepts with regard to mathematical ability are well established in the early school years and that it is very

difficult for even the best teacher to change these self-concepts in spite of the fact the potential ability is much in evidence. The student carries into his high school mathematics classes attitudes that have been developing for a lengthy period of time and hence are difficult to change.

Biggs (1959) also concluded that the personality of the teacher is not the main influence in determining the students' attitude to mathematics.

In Dutton's (1954) study among the reasons for liking arithmetic, only twenty-one out of 406 responses attributed good teachers as influential in the development of favorable attitudes, while twenty-five responses out of 157 stated that poor teachers, punishment and frightening experiences were their reasons for disliking arithmetic. Dutton also found that by the time the students reach high school their attitudes to mathematics are difficult to change. In the estimation of the 289 students, the feeling toward arithmetic developed mainly from grades three to six (fifty per cent of the students reported these grades as being periods of significant development) with a drop in the number of students reporting junior high as the place their attitude to arithmetic developed (eighteen per cent reported these grades as significant). Only seven per cent reported high school as the period of significant development of attitudes to arithmetic.

On studying students' perception of teachers Michael and Cryan (1951) found no systematic relationship between academic attainment of students and student attitudes to each of the following factors: (a) teachers' method of teaching, (b) teachers' personality, (c) confidence in the teachers' knowledge of the subject matter, (d) good marks obtained in the course, (e) short assignments, and (f) the type of classroom discipline. A set of questionnaires were administered to a total of 976 students (489 boys and 487 girls in grades eleven and twelve) ranging in age from fourteen to twenty-one years. Approximately ninety-two per cent of the students were from sixteen to eighteen years of age.

Personality Studies

Aiken (1963) was concerned with the problem of why students were afraid of mathematics. He felt that there were two main hypotheses. First, such attitudes are determined by the past rewards obtained in mathematics. However he states this does not account for the fact that for similar abilities and seemingly similar mathematics experiences the students have different attitudes to mathematics. This leads to the second hypothesis, namely that attitudes are merely another reflection of more general personality traits. Using previous research which maintained that non-intellective factors are more influential in determining the attitudes of females

toward mathematics than those of males, he chose 160 female college students as his sample. He administered a mathematics attitude scale which was shown to be a reliable and valid predictor of success for college women provided it was used in conjunction with the information from a test of mathematical ability. Also on the basis of extensive conferences with experts in the area of objective tests of personality, he chose the *California Psychological Inventory* (*CPI*), the *Sixteen Personality Factor Questionnaire* (*PFQ*), and the *Study of Values* (*SV*), as measures of personality traits. The *Scholastic Aptitude Test* (*SAT*) scores were used as measures of ability. Aiken found the *Mathematics Attitude Scale* scores significantly correlated at the .05 level or better with each of the fourteen psychological variables as well as with the *SV Theoretical Scale* and the *SAT-Mathematical Ability Scale*. He noted that only two or three out of the sixteen correlations could be expected by chance to be significant and therefore the results appear to be trustworthy. Aiken felt that these results suggest that women with more favorable attitudes toward mathematics tend to be more outgoing, conscientious, self-controlled, intellectually mature, and place more value on theoretical matters than those with less favorable attitudes toward mathematics. When Aiken partialled out the mathematical ability scores in an attempt to statistically control mathematical ability, basically the same results appeared. The *CPI* Dominance, Self-

Control, Achievement via Conformance as well Intellectual Efficiency and the 16PFQ Integration and SV Theoretical Scale were still correlated with the Mathematics Attitude Scale.

In delving into the problem of motivation in learning, Neale (1969) asks for more research:

> What is needed are comprehensive empirical studies that relate the entire domain of human motives to the attainment of objectives of schooling. Preferably, of course, such studies would also have to take account of contributions to learning of such factors as cognitive abilities, personality traits, and situational variables.[7]

In his study concerning the role of positive attitude toward mathematics and mathematics achievement, Neale cited two factors with the strongest relationship to achievement in mathematics: submissiveness (+.50) (I want to be polite to adults) and superego (+.44) (I want to show self-control). Curiosity had a negative relationship with achievement (-.20). It therefore may well be that submissiveness and superego would correlate highly with positive attitudes and that positive attitudes may thus be reflections of certain variables in the personality. Neale points out some possible personality factors which may be the real reasons for expressed positive attitudes:

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[7] D.C. Neale, The Role of Attitudes in Learning Mathematics. Mimeographed Paper, University of Minnesota, 1969.

> We are mistaken if we create in beginning teachers the impression that learning must spring from some unquenchable thirst for mathematical knowledge. We are better off to tell the truth, that children learn mathematics for a combination of reasons, which include a desire to do their duty, be good children, and gain approval.[8]

Plank (1950) investigated the psychological components of personality in an attempt to explain existing attitudes to arithmetic. In working with five retarded children (four third-graders and one fourth-grader) who were particularly retarded she found that negative attitude to arithmetic was mainly related to problems of personal adjustment rather than to intelligence or school experience. Overprotection on the part of parents caused some children to assert their independence causing them to be rejected by the group. These students also had a difficult time accepting any failure on their own part. Some suffered from a feeling of overly high expectation on the part of their parents, while others suffered from loneliness and the lack of ability to stand competition.

Negative attitudes may stem from a psychological state of anxiety. Dreger and Aiken (1957) sought evidence to determine whether number anxiety (level of nervousness when faced with mathematical work) existed as a factor distinct from general anxiety (the persons' normal state of nervousness when facing everyday affairs), and whether individuals with

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[8] _Ibid_., p. 15.

high number anxiety made lower scores in mathematics than those with general anxiety. The data showed that number anxiety appears to be a separate factor distinct from general anxiety and that number anxiety does not seem to be related to general intelligence as measured by the Wechsler-Bellevue Scale. It was also found that persons with high number anxiety tended to make lower mathematical grades than persons with low number anxiety. They administered The Taylor Manifest Anxiety Scale and The Wechsler-Bellevue Intelligence Scale, and applied the psychogalvanometer which registers palmar skin resistance (GSR), to seven hundred and four students in basic mathematics classes. It might be conjectured that a high level of number anxiety cannot be tolerated by the individual comfortably and that hence a negative attitude becomes a reflection of this deeper conflict.

Stephens (1960) in studying seventh and eighth grade accelerated classes stated that highly significant differences were found between the accelerated and the regular groups' scores on an attitude toward arithmetic questionnaire. However, in the accelerated group four students had negative attitudes to arithmetic and this Stephens suggested might necessitate interviews to ascertain what aspects of personal maladjustment existed.

Isard (1955) gave a Preferred-Choice Inventory Form ML to eighty-six college freshmen and sophomore classes.

The attitude scale showed substantial validity and reliability on the test-retest situation and was unsusceptible to intentional bias. The data were found to support the hypothesis of a substantial relationship between attitudes towards various aspects of school experience and scholastic achievement in college.

One factor which might have a bearing on attitudes to arithmetic and mathematics may be the students' ability or inability to read. Treacy (1944) compared high and low achievers in problem solving in arithmetic on fifteen reading skills by means of the Johnson-Neyman Technique with mental age and chronological age statistically controlled and concluded that weakness in this area could possibly be an explanation for low achievers having poor attitudes. The high achievers differed significantly from the low achievers in the following aspects of reading: quantitative relationships, perception of relationships, vocabulary in context, integration of dispersed-ideas, arithmetic vocabulary, vocabulary (isolated words), retention of clearly stated details, drawing of inferences from context, and reading level. No significant differences were found between high and low achievers in the prediction of outcomes, understanding of precise directions, rate of comprehension, general information, grasp of central thought, and interpretation of content.

IV. SEX STUDIES

Aiken and Dreger (1961) found that mathematics attitude was a significant factor in prediction of achievement for females but not for males. These results were based on a study using sixty males and sixty-seven females in which a multiple regression analysis was carried out to determine the predictive value of their mathematics attitude scale.

Milton's (1957) study, limited to problem solving skill in mathematics, attributed at least in part sex-role identification with facility in problem solving. On administering the Terman-Miles MF Test as the main index of sex-role identification to sixty-three male and sixty-six female university undergraduates, Milton found a positive relationship between masculine sex-role identification and problem-solving. The men who showed more feminine traits were less versed in problem solving than masculine women. That is, as a group, high masculine personalities scored better than high feminine personalities. In addition, more masculine men were better problem solvers than feminine men. This study suggests that differences in problem solving ability tend to diminish when masculinity and feminity are the basis of analysis.

Carey (1958) found evidence to support the general hypothesis that problem-solving performance is related to

sex differences in attitude toward problem solving. The data showed that men received significantly higher scores on both the attitude scale and problems than did women. As an explanation Carey hypothesized that men have been encouraged in accepting problem-solving as part of their masculine role. This was confirmed by demonstrating that correlations for womens' aptitude and attitude scores were highly significant (low aptitude correlated with low attitude, and high aptitude correlated with high attitude), but that there was no relationship between mens' aptitude and attitude scores. The results suggest that women with low aptitudes will admit they do not like problem-solving, but men with low aptitudes will not admit it.

Carey administered two pretests, one on problem-solving and one on attitudes, followed by a discussion session and two post-tests (one on attitudes and one on problem-solving) to ninety-six university students. Comparison with a control group of forty-eight students not participating in discussions showed that the difference in attitude scores from pretest and post-test was not due just to practice effect.

V. SOCIO-ECONOMIC STUDIES

Shaw (1943) found when the total group studied was divided into fourths and ranked from high (four) to low (one) according to socio-economic status, the mean rank order

of academic achievements of these groups ranked was the same as for socio-economic status. The study was done with 280 students from grades four to eight inclusive. Socio-economic status was measured by *Sims Score Cards*. Educational achievement was measured by the *Stanford Achievement Test* and by the average mark as given in the past year. Intelligence test scores were obtained from the *Otis Self-Administering Test of Mental Ability, Intermediate Examination*.

Osborn (1941) and Thorndike (1951) showed with their data that cultural differences within a school were much less than the differences found among various schools. Within any one school the background of the lower achieving student was not much different from that of the best student. In comparing schools wide differences in background were found. Also within schools a superior background was not associated with a superior performance; nor superior performance with a better background.

Engle (1934) found, as did Frankel (1960), that in school marks and intelligence quotients children from financially dependent homes had less favorable school records than children from homes selected at random, and children from homes selected at random in turn had less favorable records than children from selected privileged homes. Children from both the under-privileged homes and the privileged homes presented more disciplinary problems than children from homes selected at random. Children from the

under-privileged homes presented more disciplinary problems than children from the privileged homes. The 114 under-privileged students were those receiving public assistance and the 115 privileged students were picked by the principal who lived in the area for many years. All three groups were at the senior high school level. The intelligence quotients were scores from one of the following tests: *The Terman Group Test of Mental Ability*, *The National Intelligence Test* or *The Dearborn Group Tests of Intelligence*.

Reeder (1955) in analyzing elementary school children found that there was a significant correlation between low socio-economic status and a low self-concept. The self-concept scale developed by Reeder had high test-retest reliability coefficients. The low self-concept also correlated with lower achievement compared to the students' potential and with the existence of behavior problems.

Byrns and Henmon (1936) in analyzing one hundred thousand eight hundred twenty high school seniors concluded that evidence existed to support the hypothesis that there were true differences in average mental ability between children whose fathers belonged to different occupational groups. The occupations studied were grouped and given names of Professional, Executive, Business, Clerical, Miscellaneous, Skilled, Semi-skilled, Unskilled and Farmers. These differences between medians were found to be sufficiently large to indicate a true difference except for three

categories, namely between Business and Clerical, between Clerical and Miscellaneous, and between Skilled and Semi-skilled occupations. However, although the mental ability of children progressed from one parental occupation group to another, the correlation between the mental ability scores of the student and the rank of the parental occupation for the entire group of students was only +.18 which was due to the overlapping from group to group and to the wide range of scores in each group. Aptitude was measured by the following tests, *Ohio State University Psychological Test*, *The American Council Psychological Examination*, and *The Henmon-Nelson Test of Mental Age*. Although the professional group has the highest median mental ability, the Farmer and Labor groups (skilled, unskilled, and semi-skilled) when compared to the overall median accounted for fifty per cent of students above this overall median.

Burchinal, Gardner and Hawkes (1958) administered *The Rogers Test of Personality Adjustment* to 129 boys and 127 girls from homes that had both mother and father and at least one brother or sister. Occupations of the fathers and the educational levels of the fathers and mothers were taken as indices of the socio-economic status of the family. On the total score on scales of personal inferiority, social maladjustment, family relations and daydreaming, a fairly clear pattern emerged. Children whose fathers attended but did not graduate from high school had the highest mean scores.

Next was the mean for children whose fathers were high school graduates, followed closely by the mean of the children whose father had an elementary educational level. The second lowest mean was obtained by children whose fathers were college nongraduates and the lowest mean was obtained by fathers who graduated from college. The children from homes where the father had post graduate training had the second highest mean. When the sums of all scores from the same scales listed above were compared, the childrens' fathers whose occupations were lowest ranked highest on these tests and those students with occupations that ranked highest obtained the lowest total score.

There appears to be a direct relationship between socio-economic status and performance on aptitude tests, achievement, and attitude to school subjects with the exceptionally low and exceptionally high in socio-economic status creating the discipline problems. The students in the lower socio-economic class tended to have their progress academically retarded while those in the higher socio-economic classes tended to have their progress accelerated. Burchinal _et al_. (1958) supported the proposition that "the socio-economic status of the family in which the child is born and socialized has been demonstrated to have important influences on the attitudes, values and behavior patterns acquired by

the child."[9]

The studies cited above indicate that socio-economic status is a factor with many possible levels and is related to other variables such as attitude. Since it is related to other factors it is important to hold socio-economic status constant within a given range. However, Osborn (1941) and Thorndike (1951) stated that on the average there was not very much variation in socio-economic status in one school and hence it may be necessary to omit only a few students who are either exceptionally above or below the socio-economic standing of the main group studied.

The question then is how to rank the socio-economic status of the students involved. Tuckman (1947) indicated that the rank of occupations as a measure of social status changed very little in a period of twenty-one years. Tuckman also indicated that there was a general pattern of occupations determining socio-economic status independent of the country analyzed or the year the study was conducted. Blishen (1967) reported a scale which he developed. The choice of eighty-eight occupations were taken from the Pineo-Porter scale (1967) from which he developed regression weights and a prediction equation. Upon applying this equation to the 320 occupations obtained in the 1961 Canadian

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[9] L.B. Burchinal, B. Gardner, and G. Hawkes, "Children's Personality Adjustment and the Socio-Economic Status of Their Families," The Journal of Genetic Psychology, 92:149, 1958.

census a socio-economic index score for each was obtained. Blishen also reported that:

> The rank correlation between this index and the 1951 occupational class scale described ... was .96, indicating both stability in the structure over time and similarity in results despite variations in procedure. The coefficient of multiple correlation between the Pineo-Porter scores and the income and educational level scores described above was .919 for the eighty-eight matching occupations, indicating that the Pineo-Porter prestige scores could be estimated with a relatively high degree of accuracy.[10]

With reference to validity he stated: "The high correlation between the Pineo-Porter scale and the present index may be interpreted to support the validity of the latter."[11] Other correlations which served as indices of validity were reported as follows: .94, United States; .74 Germany; .85, Great Britain; .89 New Zealand; .90, Japan.

Pineo and Porter (1967) adapted their scale from the National Research Centre (NORC) of the U.S., changing necessary titles of occupations, and making it bilingual. It was the first national study of occupational prestige for Canada and was designed to be compared with U.S. scales. They reported that:

> The research design which we adapted required all respondents to rank 204 occupational titles. Although occupation is undoubtedly the principal element entering into a person's status there are

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[10] B.R. Blishen, "A Socio-Economic Index for Occupations in Canada," The Canadian Review of Sociology and Anthropology, 4:50, 1967.

[11] Blishen, op. cit., p. 50.

> other elements, such as the place of "situs" in which he works, ethnicity, and religion. For this reason sub-samples of respondents were required to rank seventy-two industries and corporations, thirty-six ethnicities, and twenty-one religions. As well as ranking of occupations the interview elicited social background characteristics of the respondents, their spouses, their parents, and information relating to work experience, mobility, attitudes to education and interethnic relations.[12]

Since the Blishen scale correlated so highly with the Pineo-Porter scale (.919), with the Tuckman scale (.91), and with scales of other countries as previously listed, it appears the socio-economic index for occupations Blishen reports is best suited for this study.

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[12] P.C. Pineo and J. Porter, "Occupational Prestige in Canada," The Canadian Review of Sociology and Anthropology, 4:25, No. 1, 1967.

CHAPTER III

THE ANALYSIS AND RELEVANCY OF THE SCALES AND TESTS

The scales and tests used within the present study are described in this chapter. A discussion on the relevancy, validity and reliability of the *California Psychological Inventory* (*CPI*) as well as a description of the personality traits is included. Similarly an explanation of the *Attitude-to-Mathematics Scale* as well as a discussion outlining the development of the mathematics achievement tests is undertaken.

I. THE CALIFORNIA PSYCHOLOGICAL INVENTORY

The original *California Psychological Inventory*, *CPI*, was developed to serve two goals, which according to Gough (1957) are: (a) to develop descriptive concepts for a broader setting than psychiatric clinics, with an outlook for the favorable and positive aspects of personality of normal subjects rather than the morbid or pathological, (b) to serve as an efficient and dependable scale for identification and measurement of selected personality variables. This instrument has eighteen scales grouped into four categories with a total of 480 true-false items.

Thorndike (1959) in analyzing the *CPI* stated that the problem is which ones and how many of the scales provide an

understandable description of the individual. Crites (1964) stated:

> About the only personality inventory which has been studied extensively enough both internally and externally to indicate its promise for the appraisal of the normal personality is the _California Psychological Inventory_.[13]

In the following reports on the literature pertaining to Gough's scales, one of the main problems which was investigated was that of finding those scales which measure different aspects of the personality. Attempts using statistical procedures have been made to give a clear empirical basis for clusters within the eighteen _CPI_ scales. As a result a very large percentage of the reliable variance was found to be predicted by five or six of the scales and little reliable variance remained (Mitchell and Pierce-Jones, 1960; Nichols and Schnell, 1963; Crites, 1964; Springob and Struening, 1964).

One scale relevant to this study was Self-Control. Gough (1957) stated that the purpose of this scale is "to assess the degree and adequacy of self-regulation and self-control and freedom from impulsivity and self-centeredness."[14] High scores indicate a person to be "calm, patient, practical, slow, self-denying, inhibited, thoughtful, and deliberate; as

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[13] J.O. Crites, "The California Psychological Inventory: 1. As a Measure of the Normal Personality," _Journal of Counselling Psychology_, 11:197, 1964.

[14] H.G. Gough, _Manual for the California Psychological Inventory_. Palo Alto: Consulting Psychologist Press, p. 12, 1957.

being strict and thorough in their own work and in their expectation for others; and as being honest and conscientious."[15] Low scores indicate a person as being "impulsive, shrewd, excitable, irritable, self-centered, and uninhibited; as being aggressive and assertive; and as overemphasizing personal pleasure and self-gain."[16] As mathematics is a deliberate, thought-provoking process, the writer feels high scores on self-control might be associated with high scores on mathematics performance and attitude to mathematics.

Springob and Struening (1964) conducted a study to evaluate which of the eighteen scales by Gough could effectively be used with high school juniors and seniors. Although limiting himself to studying 226 males, he came to the same conclusion as other researchers that five or six of the scales were the efficient way of measuring different aspects of personalities. Also the Self-Control Scale was found as almost a pure measure that could differentiate the type of person along the self-control -- impulsive dimension. In a study by Mitchell and Pierce-Jones (1960) analyzing 258 cases consisting of 213 females and forty-five males enrolled in a teacher training center, the Self-Control Scale was found to load .92 on the factor Gough called

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[15] Ibid., p. 12.

[16] Ibid., p. 12.

Adjustment by Social Conformity. The same scale loaded very low on the three other factors or categories Gough described.

Nichols and Schnell (1963) reported that the Self-Control Scale measured a certain factor, Value Orientation, almost solely by itself. These researchers found that this scale measures the self-control aspect of personality equally well for males as for females.

Aiken (1963) in studying 160 college sophomores at a southeastern women's college found that the CPI Self-Control Scale was significantly correlated (.01 level) with a mathematics attitude scale even when mathematical ability was partialled out. Thus, he claimed, high scorers on the attitude scale tend to be more socially and intellectually mature and more self-controlled.

Gough reported a cross-validational study of the CPI. Principals were asked to nominate the least and the most impulsive students in the five high schools where the CPI was administered. The least impulsive boys and most impulsive boys as chosen by the principal indeed had significantly different scores on the Self-Control Scale of the CPI. Similar results were found for girls.

The test-retest correlations as a measure of reliability were .68 for 125 female high school juniors and .75 for 101 male high school juniors. The consistency indicated that, although such correlations were not exceptionally high, the scales can be used in both group or

individual testing.

Support exists for the use of the Dominance and Sociability Scales as studies show meaningful correlations with attitudes to mathematics scales. Gough explains that the scale on dominance attempts "to assess factors of leadership ability, dominance, persistence, and social initiative."[17] High scores indicate a person as "aggressive, confident, persistent, and planful; as being persuasive and verbally fluent; as self-reliant and independent; and as having leadership potential and initiative."[18] Low scorers tend to be seen as "retiring, inhibited, common place, indifferent, silent and unassuming; as being slow in thought and action; as avoiding of situations of tension and decision; and as lacking in self-confidence."[19] The Sociability Scale attempts "to identify persons of outgoing, sociable, participative temperament."[20] High scorers are seen as "outgoing, enterprising, and ingenious; as being competitive and forward; and as original and fluent in thought."[21] Low scorers tend to be seen as "awkward, conventional, quiet, submissive, and unassuming; as being detached and passive in attitude; and as being suggestible and overly influenced by others' reactions and opinions."[22]

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[17] Ibid., p. 12.

[18] Ibid., p. 12.

[19] Ibid., p. 12.

[20] Ibid., p. 12.

[21] Ibid., p. 12.

[22] Ibid., p. 12.

In a study previously outlined, Aiken (1963) found a significant correlation (.05 level) between CPI Dominance and attitude to mathematics scores with ability statistically controlled.

Mitchell and Pierce-Jones (1960) found that the Dominance Scale, Self-Acceptance Scale and Sociability Scale loaded heavily, with coefficients of .76, .77, and .78, respectively, on Factor II named Social Poise. These scales loaded very lightly on Factors I, III, and IV, and hence do not measure them. The loadings indicate that any one of these scales measure equally well the factor named Social Poise as previously described. Springob and Struening (1964) suggested that the above factor could be called Self-Acceptance and Outgoingness. The writers support the contention that the Dominance, Self-Acceptance, and Sociability Scales each describe the individual as self-confident and possessing social leadership, socially aggressive or gregarious, as one who seeks to achieve positions of renown or power and positions which require some control over or supervision of others. Using statistical methods they found that Self-Acceptance (Sa), Sociability (Sy), and Dominance (Do) loaded on Factor II (Self-Acceptance and Outgoingness): .82, .82, and .71, respectively, with a maximum loading of .28 on the four other factors. Nichols and Schnell (1963) reported evidence to support the above studies. However because different statistical procedures were used, slightly

different results were found.

Crites (1964) using 124 subjects of Non-clients (data on Personal Adjustment subjects and Vocational-Educational subjects were also studied but are irrelevent to this study) reported that Dominance, Self-Acceptance and Capacity for Status measured Factor II (Extroversion) equally well.

Reliability as measured by the test-retest correlations were .72 and .71 for male high school juniors on Dominance and Sociability respectively, and 0.64 and 0.68, respectively, for female high school juniors (Gough, 1957). In testing the validity of these two scales the principals were asked to name the most and least dominant and also the most and least participant students in five high schools where the CPI was administered. The most and least dominant students as identified by the principal scored significantly differently (.01 level) on the Dominance Scale and the most and least participant students scored significantly different (.01 level) on the Sociability Scale.

Crites (1964) found that the independent Factor III sometimes called the Resigned Personality could be measured by the Communality Scale. He described such a person as realistic, patient, dependable, reliable, sincere, honest, conscientious, tactful, moderate, and likely to use common sense and good judgement. The writer expresses the opinion that the realistic, dependable, conscientious person

would possess a better attitude to mathematics as well as performing better in it.

Gough (1957) stated that high scorers on the Communality Scale were seen as being "dependable, moderate, tactful, reliable, sincere, patient, steady, and realistic; as being honest and conscientious; and as having common sense and good judgement."[23] Low scorers were seen as being "impatient, changeable, complicated, imaginative, disorderly, nervous, restless, and confused; as being guileful and deceitful, inattentive and forgetful; and as having internal conflicts and problems."[24]

According to Crites (1964), Flexibility, Factor IV, and Achievement via Independence measure the same factor which Mitchell and Pierce-Jones (1960) called Capacity for Independent Thought and Action. Springob and Struening (1964) supported with empirical data the contention that Flexibility (Fx) and Achievement via Independence (Ai) measure the same factor but they measure no others. The Flexibility and Achievement via Independence Scales loaded .61 and .56 respectively on Factor IV thus measuring this factor equally well.

Gough (1957) reported that the Flexibility Scale (Fx) "indicates the degree of flexibility and adaptability of a

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[23] Ibid., p. 13.

[24] Ibid., p. 13.

person's thinking and social behavior."[25] High scorers were seen as being "insightful, informal, adventurous, confident, humorous, rebellious, idealistic, assertive, and egoistic; as being sarcastic and cynical; and as highly concerned with personal pleasure and diversion."[26] Low scorers were seen as being "deliberate, cautious, worrying, industrious, guarded, mannerly, methodical, and rigid; as being formal and pedantic in thought; and as being overly deferential to authority, custom and tradition."[27]

Gough (1957) also reported that on a validity study with 180 college students responding, Flexibility correlated -.58 with the California F (authoritarian personality) Scale. The reliability of this scale as shown by the test-retest correlations was reported as .67 for 125 high school females and .60 for 101 high school males.

Fair (1959) found a low negative significant relationship between the CPI Flexibility Scale and academic achievement for students attending various faculties at the University of Alberta. He suggested as an explanation that such individuals may be rebellious and may not apply themselves effectively to their studies.

The Femininity Scale, measuring Factor V according to Crites (1964), was used to assess the masculinity or

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[25] Ibid., p. 13.

[26] Ibid., p. 13.

[27] Ibid., p. 13.

femininity of interests. High scores indicated more feminine interests, low scores more masculine interests. The high scorers were seen as being "appreciative, patient, helpful, gentle, moderate, persevering, and sincere; as being respectful and accepting of others; and as behaving in a conscientious and sympathetic way."[28] The low scorers were seen as being "outgoing, hard-headed, ambitious, masculine, active, robust, and restless; as being manipulative and opportunistic in dealing with others; blunt and direct in thinking and in action; and impatient with delay, indecision, and reflection."[29] The aspect of masculinity-femininity is important in this study since attitude toward and performance in mathematical problem-solving was found to be not necessarily linked to males or females but rather to masculinity and femininity, with masculine females and males scoring better than feminine females or males (Milton, 1957). Fair (1959) stated that from his data there was some indication that the CPI Femininity Scale may be an indicator of academic achievement.

In discussing the selection of the items to test femininity-masculinity, Gough (1957) reported that the scale devised was easy to administer, relatively subtle and unthreatening in content and significantly differentiated between psychological masculinity and femininity.

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[28] Ibid., p. 13.

[29] Ibid., p. 13.

Two main problems with personality questionnaires are that persons tend to answer in a socially desirable way or to answer true to positively worded statements, a predisposition termed acquiescence (Jackson and Lay, 1968; Jackson and Messick, 1958; Jackson, 1960; Charles Dicken, 1963).

Cantor (1963), upon analyzing experiments with hospital patients who faked their responses and thereby changed their profile, saw that the ability to do so was related to favorable reports for discharge from the hospital. The falsification of test scores in the direction of socially acceptable answers on the CPI seemed to be an indication of a personality variable in its own right and not an undesirable factor to be corrected. Cantor, pressing the matter further, studied seventeen male applicants for a position at the hospital, and thirty alcoholics committed involuntarily. The median ages of the two groups of subjects were forty-three and forty-one years, respectively, and their socio-economic status was generally the same. The alcoholic group was divided into two, one being the better adjusted alcoholics and the other being the poorer adjusted alcoholics. The three groups were given instructions to "fake good". The normal applicants were able to fake better than either group of alcoholics. Also, using fifty applicants for a position at the hospital and fifty alcoholic patients under normal administration of the CPI test, the applicants who

were well-adjusted produced more socially acceptable answers than the alcoholics who were maladjusted and had the same opportunity to fake good. Cantor explained this as follows:

> The results suggest that, under standard conditions of administration and where there is presumed motivation the part of subjects to present themselves as normal or well adjusted, there is a positive relationship between the ability to present a good picture on the CPI and the actual life adjustment of the subject. In addition, under fake good instructions, subjects are able to improve their test pictures to a considerable degree but even here there is limitation by actual life adjustment.[30]

Dicken (1963) found it futile to attempt to control response set variance since there were no significant gains in validity. He concluded: "The available evidence supports Gough's position that social desirability variance need not and perhaps should not be removed from scales designed to measure personality traits of the type studied here."[31]

Gough (1957) stated that there was a safeguard for the type of faking in which the person attempted to write the test but had not attempted to concentrate or gave answers at random. Gough stated: "When the score on Communality falls very low, the strong possibility is raised that his answers

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[30] Francis M. Cantor, "Simulation on the California Psychological Inventory and the Adjustment of the Simulator," Journal of Consulting Psychology, 27:255, 1963.

[31] C.F. Dicken, "Good Impression, Social Desirability, and Acquiescence as Suppressor Variables," Educational and Psychological Measurement, 23:716, No. 4, 1963.

have been given in some random or unmeaningful way."[32] Gough also stated that the CPI was more difficult to fake than other tests because of the subtle items, that is, the items do not show, upon inspection, any relationship to the particular trait that they measure.

Since reading ability was a crucial factor in the normal completion of the CPI, literature on the reading level required was investigated. Bennett and Rudoff (1957) found that the sixth grade reading level was sufficient to complete the test in a satisfactory manner. Also worthy of note is that the CPI scales measure the personality of girls equally well as the personality of boys (Gough, 1957).

II. THE ACHIEVEMENT TESTS

According to Avital (1968) his taxonomy identifies three levels of mathematical thinking which are: recognition and recall which are at the taxonomic level of knowledge; algorithmic thinking and generalization which are at the taxonomic levels of Comprehension and Application; and open search at the taxonomic levels of Analysis and Synthesis. The basic level of the thinking process is the recall or recognition of material in the form it was taught. A higher level of the thinking process, which he calls algorithmic thinking, is the straightforward generalization

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[32] Gough, *op. cit.*, p. 19.

or transfer from the learned material to material similar to it. The student at this level is exposed to well-defined procedures or algorithms for solving a problem and is expected to solve problems which are not very remote from it. Avital used the term open search for the third level of cognitive complexity since this best described what goes on at the highest level of mathematical thinking. Behavior at this level emerges when the student is not confined to a learned set of responses which can be transferred directly to solving problems. He can decompose the problem into its elements (analysis) and perceive, among their rearrangements, new relationships (synthesis) which are relevant to the possible solution of the problem.

Avital (1968) states explicitly what constitutes each level:

> Knowledge, the lowest category, involves pure recall or repetition of material in the exact form in which it was presented. Memorization of facts, definitions, rules, procedures, and theories falls into this category, but if the student is expected to translate a fact into a new form or to recognize a rule stated in a different way from that in which it was presented, he is demonstrating performance in a higher category.... The reader should notice that objectives are not stated as 'the student should know...,' for knowledge in this sense can refer to at least two distinct abilities: ability to repeat and ability to use. The first is the only sense which is included in the category of Knowledge, while the second may refer to the higher levels of Comprehension and Application or even to ability to use the highest levels of problem-solving.[33]

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[33] Shmuel Avital, and Sara Shettleworth, Objectives for Mathematics Learning, Some Ideas for the Teacher (The Ontario Institute for Studies in Education, Bulletin No. 3, 1968).

The taxonomic levels of Comprehension and Application are those in which the material requires a process of generalization or simple transfer. For instance the translation of mathematical symbols falls in the category of Comprehension. There is some difficulty in distinguishing Comprehension from Application. The 'story' problems where students apply given principles to everyday situations usually belong to the category of Application. However, if the student has previously been exposed to exercises of the same type as any of the test items, his performance will be on the level of Comprehension rather than Application (Avital, 1968).

The essential requirements for a problem to belong to the open search level of the thinking process with its corresponding taxonomic levels of Analysis and Synthesis rather than to the Comprehension - Application category are three-fold. According to Avital:

> These criteria are: (i) the number of principles of rules needed for solving, (ii) the remoteness of the rule from the clues included in the formulation of the problem and the directions for solving, and (iii) the remoteness of combining the rules in a way needed for solving the given problem. The essential characteristic is nonroutine manipulation of previously learned material and, at a higher level, discovery of relationships among previously unrelated concepts and propositions.... The difference between algorithmic thinking and open search is essentially that between reproductive and productive thinking.[34]

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[34] _Ibid._, pp. 8, 9.

Based on Avital's taxonomy, basically derived from Bloom's taxonomy, a two-part test was prepared to measure the achievement of the students at the grade eight level. It was felt that there were definite distinctions between Knowledge, Comprehension, Application and Analysis and Synthesis and thus independent tests could be formed. The first part on Knowledge, Comprehension, and Application was gleaned from grade seven and eight material. It was established that for each item in the Knowledge, Comprehension, or Application category, the basic knowledge had been taught to the students. This according to Avital (1968) was essential.

It was necessary to use primarily grade seven material with only one section of grade eight material since by the time of final testing the students would not have covered sufficient material from which a representative sample of questions could be obtained. Most items for the Analysis and Synthesis section were selected from Avital's selection of problems for grades six-to-nine. However, the chosen problems were adjusted to suit the grade eight level.

A degree of content validity for the mathematics tests was obtained by submitting the items to several mathematics educators for constructive criticism. Also it is believed that the mathematics tests had acceptable content validity for the purpose they were designed since the concepts were derived from materials widely used in the school system.

The mathematics achievement tests were originally devised in two parts. The first consisted of items directly related to the grade seven material with one chapter on geometry from grade eight material. The second part was the problem type of test. These two tests were administered to fifty-three and fifty-one students, respectively, in a pilot study to determine the difficulty and the validity or discriminative power of the tests. It was also necessary to observe the time required to complete the tests.

The test on the taxonomic levels of Analysis and Synthesis had a Kuder-Richardson reliability coefficient of .23. This was probably due to the limited number of questions (10 problems) but since testing time had to be considered the test could not be lengthened. It can be shown, according to Ferguson (1959), that if the test would have been five times as long, that is fifty questions, the reliability would be near .59 by the Spearman Brown formula for estimating reliability with increased test length.

The reliability coefficient for the Knowledge, Comprehension and Application levels of the taxonomic objective was .64, which according to Garrett (1959) is as good as can be expected for a non-standardized test. The levels just stated are not necessarily independent since according to Avital (1968) if a problem in the Application or Comprehension levels was practised by the student, then it comes under the Knowledge level. Many of the items of

knowledge under our educational system are extended and expanded to the Comprehension and Application levels. Thus it appears that these categories are not independent in practice and as such it seems reasonable to say that the test measured much the same attributes. Consequently it makes sense to use Kuder-Richardsons' Formula 20 as a reliability estimate. The items retained and discarded are found in Appendix B.

III. THE ATTITUDE-TO-MATHEMATICS SCALE

The attitude to mathematics scale prepared by Remai (1965) was selected for use. He chose the multiple choice type of scale. Remai describes the scale as follows:

> The stem of each item has five possible completion responses. The student marks one of these responses to complete the stem. These choices are weighted from five to one with the response indicating the most favorable attitude, as judged by the writer, being weighted as five and least favorable as one. The total score on the attitude scale represents the sum of the weights as indicated by the marked responses to the items. The highest possible score is 125 and the lowest is 25.[35]

Upon actual inspection of Remai's attitude scale one finds twenty-four questions, not twenty-five as he stated. Thus 120 points is the maximum and 24 is the minimum.

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[35] H.A. Remai, "An Experimental Investigation Comparing Attitudes Toward Mathematics of Modern and Traditional Mathematics Students at the Junior High School Level" (unpublished Masters Thesis, University of Alberta, Edmonton, 1965), p. 47.

Validity was determined by observing the relation of verbal responses to outside criterion measures of attitudes. Remai took two measures of outside criteria: teacher rating of the students' attitude to mathematics, and students' Easter mathematics marks. The correlation between teacher ratings and the attitude scale yielded a concurrent validity coefficient of .43 and between students attitudes to mathematics and achievement in mathematics a construct validity coefficient of .37. Teachers' rating of students' attitude to mathematics and students' mathematics marks correlated .83. The stability of the trait as measured by the test-retest reliability coefficient of .77 was based on the original two groups of grade nine classes with twenty-four members in each class. As a measure of internal consistency, a coefficient of .86 was obtained for this attitude scale.

Corcoran and Gibb (1961) stated:

> ... measures of internal consistency reliability, such as the Kuder-Richardson procedures ... often yield reliabilities in the .70's and even the .80's with well constructed attitude scales in which a well-defined attitude object is appraised.[36]

It appears therefore that an attitude-to-mathematics scale such as this will differentiate extreme groups consistently

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[36] Mary Corcoran, and E.G. Gibb, "Appraising Attitudes in the Learning of Mathematics," The National Council of Teachers of Mathematics. Twenty-sixth Yearbook, p. 121, 1961.

and is therefore useful in this study. Also since the scale was constructed using students who were a year removed from grade eight, it appears the scale is valid for this study. As seen by Corcoran and Gibb (1961), in administering an attitude scale sufficient rapport with the students should be gained so the students can feel confident in expressing themselves. The use of the results of the scale should be described to them and instructions should be given to spend only a short time in completing any one question since this tends to encourage spontaneous and therefore truthful responses.

Remai points out that the total score of the attitude scale should be used by summing the weighted responses since experts in measurement observe attitude as an abstraction from a large number of related responses.

A description of the attitude measures in this study is given below. The attitude measured by Remai's Attitude-to-Mathematics Scale corresponds to the description of the fourth level of attitude cited by Neale (1969). This fourth level describes primarily attitude toward learning mathematics or interest in mathematics.

Neale (1969) identifies four areas of attitudes. First there is mathematics as a process where on one hand it can be viewed as a fixed, formal system, in which one masters a rigid set of unchanging rules. On the other hand, one can view it as a changing system allowing for different

views and a process which requires much understanding. Second, there is the difficulty of learning attitude. On one hand, one can think of mathematics for the elite and on the other as a system which can be learned by anyone. Third, there is the attitude of the place of mathematics in society. One can look on it as a luxury or as a necessity to a nation. Last, there is the attitude toward learning mathematics or interest in mathematics. This is the attitude that is specifically being analyzed in this study. It measures aspects of liking or disliking of mathematics, tendency to engage in or avoid mathematical activity, a view that one is good or bad in mathematics, and a view that mathematics is useful or useless. It is not the aim in this study to analyze the other three levels as given by Neale (1969) or to investigate the areas of intensity, or salience (the importance an individual attaches to the attitude) as given by Corcoran and Gibb (1961). The attitude analyzed in this study is specifically the attitude toward learning mathematics or the interest in mathematics. Remai's Attitude-to-Mathematics Scale appears to measure this specific area of attitudes well.

CHAPTER IV

EXPERIMENTAL DESIGN AND STATISTICAL PROCEDURES

I. THE EXPERIMENTAL DESIGN

The present chapter contains a description of the experimental and the statistical methods used. Included are a listing of the null hypotheses tested, the sampling and testing procedures used and a discussion of the bases upon which the various statistical decisions were made.

One of the purposes of the present study was to clarify the relationship among the following variables: personality, achievement in mathematics, attitude to mathematics, and sex. Information about the interactions of these variables was gathered as well as information about the association of the selected personality traits with levels of these factors. Since grouping or categorization of students into levels is still a necessary administrative task, knowledge of the personality patterns within groups and between groups would likely be of value to those persons associated with mathematics learning. A study of the interactions appeared important since the results could possibly be used as a basis for differentiated instruction and materials.

Another purpose of this study was to assess the importance of personality traits in predicting mathematical

performance as well as attitude.

To attain these ends the California Psychological Inventory (CPI), the Attitude to Mathematics Scale and the Mathematics Achievement Tests, as described in Chapter Three were administered to six grade eight classes in January, 1970. From the total of 184 students, 147 were selected after the students whose reading ability was below the grade seven level, or whose record indicated having one parent, or whose record indicated a substantially lower or higher socio-economic status than the majority as determined by the Blishen (1967) scale, were eliminated. The rationale underlying the choice of qualifying students was given in Chapter One of the present study.

Eleven scores were obtained from the administration of the following scales and tests: Attitude-to-Mathematics Scale, Achievement within the Knowledge, Comprehension and Application taxonomic level (referred to as A1), Achievement within the Analysis and Synthesis taxonomic level (referred to as A2), Achievement considered as the scores of A1 and A2 summed (referred to as A3), Self-Control, Dominance, Sociability, Communality, Flexibility, and Femininity. Since the taxonomic levels, as defined previously in this thesis, corresponded to theoretically different mental processes, the analyses attempted to clarify the personality traits associated with achievement and attitude within each taxonomic level. Similarly clarification of the operating

personality traits within ranges of general intelligence was attempted. As a result, with the use of Pearson product-moment correlations, the entire sample was first studied. Then narrow I.Q. ranges, arbitrarily defined as follows, were studied: 84-94, 95-109, 110-120, 121-136.

II. THE NULL HYPOTHESES

The hypotheses to be tested using the Three-way Analysis of Variance Method are:

Hypothesis I

A. There is no significant difference in scores between students of high mathematical achievement and students of low mathematical achievement on the CPI scales: Sc, Do, Sy, Cm, Fx, Fe.

B. There is no significant difference in scores between students of high mathematical achievement and students of middle mathematical achievement on the CPI scales: Sc, Do, Sy, Cm, Fx, Fe.

C. There is no significant difference in scores between students of middle mathematical achievement and students of low mathematical achievement on the CPI scales: Sc, Do, Sy, Cm, Fx, Fe.

Hypothesis II

A. There is no significant difference in scores between students with high attitudes to mathematics and students with low attitudes to mathematics on the CPI scales: Sc, Do, Sy, Cm, Fx, Fe.

B. There is no significant difference in scores between students with high attitudes to mathematics and students with middle attitudes to mathematics on the CPI scales: Sc, Do, Sy, Cm, Fx, Fe.

C. There is no significant difference in scores between students with middle attitudes to mathematics and

students with low attitudes to mathematics on the CPI scales: Sc, Do, Sy, Cm, Fx, Fe.

Hypothesis III

Males as a group will not score significantly differently than females on the CPI scales: Sc, Do, Sy, Cm, Fx, Fe.

If interactions exist, they will be interpreted separately.

The hypotheses to be tested using Stepwise Regression Analysis are:

Hypothesis IV

The efficiency of prediction of mathematics achievement scores of grade eight students over and above general intelligence is not significantly improved by adding scales on:

(a) attitude to mathematics

(b) personality

(1) Self-Control
(2) Dominance
(3) Sociability
(4) Communality
(5) Flexibility
(6) Femininity

Hypothesis V

The efficiency of prediction of attitude to mathematics scores of grade eight students is not significantly improved by scales on:

(a) general intelligence

(b) personality

(1) Self-Control
(2) Dominance
(3) Sociability
(4) Communality

    - (5) Flexibility
    - (6) Femininity

- (c) achievement

    - (1) A1
    - (2) A2
    - (3) A3

III. THE POPULATION

The total population from which a sample was drawn consisted of 183 students from two Edmonton Junior High Schools. These schools are located in approximately the same neighbourhood and were chosen because the writer had taught in the larger one. This meant two things. First, the writer knew what was taught specifically in this and the previous year. Inspection of the other school's mathematics objectives showed that very similar content was taught. The knowledge basic to both taxonomic levels was to be taught in order for the tests to be valid (Avital, 1968). Second, the choice of these schools was desirable because sufficient rapport with the students had been previously established. This rapport was essential for the Attitude-to-Mathematics Scale and the CPI, since more truthful answers were likely to be gained (Corcoran and Gibb, 1961). The average age of the students was approximately thirteen years, eight months. The schools were considered to be in the upper middle class district.

IV. SAMPLING AND COLLECTING DATA

To facilitate administration of the scales and tests, the Attitude-to-Mathematics Scale, the CPI and two Mathematics Achievement Tests were administered to six grade eight classes in January, 1970. The students whose socio-economic status as determined by the Blishen (1967) scale and whose reading ability did not meet the criterion set out for this study were disregarded. The students from broken, separated, or one-parent homes were also not included. The qualified students were categorized into high, middle and low attitude groups and similarly partitioned achievement groups. Male students were categorized separately from female students.

V. STATISTICAL METHOD OF DATA ANALYSIS

It was an aim of the present study to determine if certain personality traits could make a significant contribution to the prediction of mathematics scores over and above general intelligence. Pearson product-moment correlations were used to determine if meeting the requirements of the Three-Way Analysis of Variance method resulted in loss of information due to loss of data in conforming to the requirement of equal or proportional cell frequencies. Correlations also indicated which scales were associated with achievement. Similar information regarding personality traits associated with positive attitudes was sought. Stepwise

Regression procedures were used to determine which of the scales contributed significantly to the prediction of achievement over and above general intelligence. This procedure also gave the percentage of the variance predicted by the scales that contributed significantly to prediction. The method would also indicate which personality traits would contribute significantly to the prediction of attitude to mathematics.

The efficiency of prediction, Stepwise Regression, and Multiple Regression are related to multiple correlation. According to Ferguson (1959), multiple correlation deals with the calculation of weights that produce the highest possible correlation between the dependent (criterion) variable and the weighted sum of two or more predictor variables. Its purpose is to maximize the efficiency of prediction. Blalock (1960) showed that the square of the multiple correlation coefficient will be equal to the percentage of the variation explained by all the independent variables assuming a linear-type model. This process, he explains, shows the total explained variation of the criterion where the overlap of the independent variables is accounted for so that no duplication exists.

For brevity the special case instead of the general case is cited here. The special case involving the three variable problem is:

$$R^2_{1.23} = \frac{r^2_{12} + r^2_{13} - 2r_{12}r_{13}r_{23}}{1-r^2_{23}}$$

Where $R^2_{1.23}$ represents the squared multiple correlation between variables X_1 (criterion) and a combination of variables X_2 and X_3, where r_{12}, r_{13}, r_{23} represent the product-moment correlations among X_1, X_2 and X_3.

It can be shown that one can obtain a high R^2 and therefore a high R when r_{23} is small, r_{12} is large and r_{13} is large. This suggests that one requires predictors whose correlation between themselves is small but with the criterion is large. It should be noted that spuriously high R^2 could be attained with a suppressor variable. A suppressor variable may be present if r_{23} and r_{21} are large, and r_{13} is small. Thus two predictors could each predict approximately as well but both are not required. A check for suppressor variables will be made.

Stepwise Regression Analysis was used to determine which scales added most effectively to prediction. According to Efroymson (1960) the stepwise procedure gives a number of intermediate regression equations as well as the complete regression equations found through the Multiple Regression Analysis procedure. He stated that the equations would be attained by adding one variable at a time with the added advantage that if a variable used first was found to be inadequate as compared to other variables added later, the

insignificant one would be dropped. With the computer program at the University of Alberta the user can select the level of significance at which the variable could be entered into the equation. The equations may be represented as:

$$y = b_0 + b_1X_1 + e_1$$

$$y = b_0' + b_1'X_1 + b_2'X_2 + e_2$$

$$y = b_0'' + b_1''X_1 + b_2''X_2 + b_3''X_3 + e_3$$

$$\vdots$$

Where y is the dependent (criterion) variable,

X_1, X_2, ... are the independent (predictor) variables,

b_0, b_1, ... are the coefficients that produce the best fit, and e is the error term (difference between predicted and actual values of the dependent variables).

This would be the best fitting equation to the data in the sense that the e^2 (error^2) would be minimum for the particular combination of criterion and predictors. That is, for each equation developed, the next variable added accounted for the greatest proportion of the remaining variance of the criterion variable.

Since the educational process uses groupings and categorization of students into levels, it was felt that the results of the present study would have more practical application if levels were analyzed.

Since three factors: achievement, attitude and sex were to be studied, a factorial design was considered with three levels of attitude, three levels of achievement and the two levels of sex. The factors and levels can be represented as in Table I.

TABLE I

FORMAT OF THE FACTORIAL DESIGN

Achievement	Attitude to Mathematics					
	High		Middle		Low	
	Male	Female	Male	Female	Male	Female
High	n	n	n	n	n	n
Middle	n	n	n	n	n	n
Low	n	n	n	n	n	n

Here 'n' represents a certain number of students. The students were independently chosen for each cell. When the entire sample was analyzed for A3, the sum of scores for the two taxonomic levels, 'n' equal to seven per cell, resulted in data on 126 students from the 147 qualifying students being included in the analysis. When achievement within A1, the lower taxonomic level, and A2, the higher taxonomic level, were taken separately, 'n' equal to six per cell resulted in data for 108 students being analyzed. For the I.Q. level ninety-five to one hundred and nine, 'n' was equal to two, resulting in data for thirty-six students analyzed. For the I.Q. level ninety-five to one hundred and

nine, 'n' equal to two was also used. The results with 'n' equal to two should be viewed with caution. Due to the already high possibility of error when 'n' is equal to two, attempts for other levels, which contained fewer subjects, were abandoned. The two I.Q. levels analyzed had the greatest proportion of students per level.

Winer (1962) stated that a factorial design allows the investigator to make a wide range of decisions and provides information about each separate variable as well as the results of two or more variables considered simultaneously. Since factor analysis of variance requires that equal or proportionate numbers of scores in various subgroups be obtained, Lewis (1968) suggested:

> One way would be to allow for this possibility from the beginning, and to include in each subgroup slightly more pupils than would finally be needed. Exact equality or proportionality could be attained afterwards by randomly rejecting scores from the unduly large subgroups. If only a few scores have to be rejected, this might be the most sensible method to adopt.[37]

The fixed model was used since the levels of the factors were not subject to sampling. The components for the three factors are as follows, where all three main effects are fixed.

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[37] D.G. Lewis, Experimental Design in Education (London: University of London Press Ltd., 1968), p. 100.

TABLE II

COMPONENTS ANALYSIS FOR A THREE-FACTOR EXPERIMENT, ALL THREE EFFECTS BEING FIXED

Source of Variation	Degrees of Freedom	Mean-Square Expectation
A	a-1	$\sigma^2 + nbc\ \sigma_A^2$
B	b-1	$\sigma^2 + nac\ \sigma_B^2$
C	c-1	$\sigma^2 + nab\ \sigma_C^2$
A X B	(a-1)(b-1)	$\sigma^2 + nc\ \sigma_{AB}^2$
A X C	(a-1)(c-1)	$\sigma^2 + nb\ \sigma_{AB}^2$
B X C	(b-1)(c-1)	$\sigma^2 + na\ \sigma_{BC}^2$
A X B X C	(a-1)(b-1)(c-1)	$\sigma^2 + n\ \sigma_{ABC}^2$
Within Cells (e)	abc(n-1)	σ^2

These are written for 'a' levels of 'A', 'b' levels of 'B', 'c' levels of 'C', and for 'n' scores in each of the 'abc' groups. The A's, B's, C's, AB's, AC's, BC's, ABC's and e's of the model are regarded as being drawn from normally distributed populations with means of zero and variances of σ_A^2, σ_B^2, σ_C^2, σ_{AB}^2, σ_{AC}^2, σ_{BC}^2, σ_{ABC}^2 and σ^2 respectively.

An analysis of main effects and simple main effects if interaction exists with due care to the limiting effect of the three-way interaction effect upon the interpretation of the two way interaction effect will be carried out.

Underlying the whole structure of the analysis are

three assumptions. According to Ferguson (1959) and Winer (1962) these are: (1) the normality of the distributions of the variables; (2) the variances in the populations from which the samples are drawn are equal; and (3) a given observation may be partitioned into independent and additive bits, each bit resulting from an identifiable source. Ferguson (1959) states that in most cases there are no grounds to suspect the validity of this model. Both Winer (1962) and Ferguson (1959) state that these assumptions are robust, that is, reasonable departure from normality and homogeneity should not affect the results of the analysis.

Three-Way Analysis of Variance procedure would help to clarify interactions as well as the effects of personality when levels of achievement and attitude are considered. In practical educational work categorization of students into levels is a common and at present a necessary practice.

CHAPTER V

EXPERIMENTAL RESULTS

I. INTRODUCTION

This chapter presents the experimental results in three major sections. The first section, containing only Part A, presents the findings with respect to the relationships among the variables. The total sample as well as groups within selected I.Q. levels were analyzed and the Pearson product-moment correlations interpreted. The second section, consisting of Parts B, C, D and E presents the findings when levels of achievement, attitude and sex were considered. Part B of this section includes the findings when the entire sample and total achievement, A3, were analyzed. Part C shows the findings when the entire sample and achievement within the lower taxonomic level, A1, were studied. Part D contains the results when the entire sample and achievement within the higher taxonomic level, A2, were analyzed. Part E includes the findings when two levels of general intelligence were studied. The Three-Way Analysis of Variance procedure was used in Sections B, C, D and E. The third section, consisting of Part F, presents the findings of the personality variables which contributed to the prediction of mathematics scores. This section did not take levels into consideration. The statistical

procedure used was Stepwise Regression Analysis.

II. PART A: EXPERIMENTAL RESULTS - PEARSON PRODUCT-MOMENT CORRELATIONS

When achievement was analyzed for the entire sample of 147 subjects, achievement was found to be significantly associated with personality traits. This association means, if the relationship was positive and significant, that an increase in achievement meant an increase in the personality trait score.

Tables III through VII, found in the Appendix, indicate the correlations found for the eleven variables when I.Q. was held constant within a narrow range. Also the results of the correlations using the entire sample is given.

The following results from the analyses by correlations refer to the Tables III through VII found in Appendix A.

Table III indicates that achievement: A1, A2, and A3 were related to several personality traits, and that almost all variables with the exception of self-control and femininity were significantly related to I.Q. This indicates that grouping students according to general intelligence could also provide homogeneous groups with regard to dominance, sociability, communality and flexibility.

The correlational method indicates that when the I.Q. range 84-94 was analyzed, there were no personality variables related to achievement nor to attitude. When I.Q. range

95-109 was analyzed, there were no personality variables related to achievement but self-control was related to attitude. When I.Q. range 110-120 was tested, communality was related to achievement: A1, A2 and A3. Sociability and communality were related to attitude. Flexibility was negatively related to attitude. For the I.Q. range 121-136, self-control was related to achievement A2, dominance was related to A1 and A3, and self-control was related to attitude. For each I.Q. range cited above the data are found in Tables IV through VII respectively.

Since the correlation between attitude and self-control was large, the correlation between attitude and achievement, large, and the correlation between self-control and achievement A3, small, when compared to the other two correlations, attitude could possibly act as a suppressor variable. Thus if one chose self-control, this would likely enable prediction of achievement almost as well as using the attitude scale.

III. DESCRIPTION OF THE FORMAT FOR REPORTING THREE-WAY ANALYSIS OF VARIANCE RESULTS

The procedure generally used in presenting a summary of Three-Way Analysis of Variance results will be used here. This procedure using the .05 level of significance may be summarized as:

(1) A presentation of statistical data for the Three-Way Analysis for each scale.

(2) Examination of interaction effects. If three-way interactions exist this will be interpreted. If two-way interactions are found, the following will be presented:

  (a) a graphical presentation,

  (b) a test for significance of simple main effects.

(3) Examination of significant main effects by means of the Newman-Keuls method of testing the significance of the differences between all pairs of means.

The null hypotheses to be tested through the above procedure are listed below. These are consistently referred to so that constant re-writing of them is not necessary. Hypotheses IV and V, tested by Regression Analysis follows this section of analyses.

Hypothesis I

A. There is no significant difference in scores between students of high mathematical achievement and students of low mathematical achievement on the CPI scales: Sc, Do, Sy, Cm, Fx, Fe.

B. There is no significant difference in scores between students of high mathematical achievement and students of middle mathematical achievement on the CPI scales: Sc, Do, Sy, Cm, Fx, Fe.

C. There is no significant difference in scores between students of middle mathematical achievement

and students of low mathematical achievement on the CPI scales: Sc, Do, Sy, Cm, Fx, Fe.

Hypothesis II

A. There is no significant difference in scores between students with high attitudes to mathematics and students with low attitudes to mathematics on the CPI scales: Sc, Do, Sy, Cm, Fx, Fe.

B. There is no significant difference in scores between students with high attitudes to mathematics and students with middle attitudes to mathematics on the CPI scales: Sc, Do, Sy, Cm, Fx, Fe.

C. There is no significant difference in scores between students with middle attitudes to mathematics and students with low attitudes to mathematics on the CPI scales: Sc, Do, Sy, Cm, Fx, Fe.

Hypothesis III

Males as a group will not score significantly differently than females on the CPI scales: Sc, Do, Sy, Cm, Fx, Fe.

In analyzing the data, it was an aim of this study to see whether or not there existed any distinct association of personality traits with the levels of achievement, attitude and sex for the entire sample. When the entire sample was analyzed, the final results with respect to attitude were a composite of the three substudies, Parts B, C and D, in this chapter. Basically the attitude limits governing entry into the classification categories of high, middle and low were shifted somewhat in order to obtain equal cell membership. It was evident from the various distributions of achievement scores for each taxonomic level that there could be no

pre-determined limits that could be used in classifying high, middle or low attitudes. However, the results were substantiated by correlational methods.

The reading of the literature (Aiken, 1963) indicated that even when ability was held constant within a given range, the difference in attitude within this group might be associated with personality traits. This claim as well as the association of personality with achievement were investigated within the present study.

According to Winer (1962) a stratification procedure is superior to statistically controlling I.Q. by the Analysis of Covariance method. However, when I.Q. was statified the samples within these ranges were small. Due to the high possibility of inaccurate results, a study of the samples within the narrow I.Q. ranges by means of the Three-Way Analysis of Variance procedure was abandoned once those ranges with the highest numbers of subjects were analyzed. Part E contains the analyses within ranges and should be viewed with caution since 'n' equal to two was used. Information in this area was gained by the use of Pearson product-moment correlations and Stepwise Regression Analysis. However these latter two methods of analysis did not provide information regarding interaction effects or personality variables associated with levels of achievement and attitude.

The achievement category (A1, A2 or A3) is clearly

stated at the beginning of each section and is thereafter referred to as "achievement". Within the analyses, "A" refers to achievement, "B" refers to attitude, and "C" refers to sex. The tables to which reference is made in the present study are found in Appendix A.

IV. PART B: EXPERIMENTAL RESULTS USING THE ENTIRE SAMPLE AND ACHIEVEMENT A3

The Three-Way Analysis of Variance results for the six CPI scales: Self-Control, Dominance, Sociability, Communality, Flexibility, and Femininity are now presented.

Statistical Results for the CPI Scales: Sc, Do, Sy, Cm, Fx, Fe for the Entire Sample and Achievement A3

(1) Statistical Results for the CPI Self-Control Scale

As indicated in Table VIII Hypothesis I-A, I-B, and I-C were not rejected. For different levels of achievement, scores on the Self-Control Scale were not significantly different. Hypothesis II-A, II-B, and II-C were rejected. An overall significant difference on the Self-Control Scale scores for the levels of attitude was found. The Newman-Keuls method was used to compare pairs of means since an overall significant F was found.

Table IX indicates that the group with high attitudes differed significantly from the other two groups on the

self-control dimension. This table also shows that the middle and low-attitude groups did not differ significantly with regard to self-control.

Hypothesis III was accepted. Males did not differ from females in self-control.

(2) Statistical Results for the CPI Dominance Scale

Since Table X shows a significant overall F value for the achievement levels and attitude levels, the Newman-Keuls method was used to compare pairs of means.

Hypothesis I-A was rejected, but I-B and I-C were not. This indicated that the high achievers were significantly different in dominance as compared to the other two levels of achievement. According to Table XI, the other two levels were not significantly different in dominance.

Hypothesis II-C and II-B were not rejected. Table XII indicates that students with low or high attitudes did not possess significantly higher scores in dominance than the middle-attitude group. However, Hypothesis II-A was rejected. The high and low attitude groups differed significantly on the Dominance Scale.

There is no evidence on which to reject Hypothesis III. Significant differences between the male scores and the female scores did not appear on the Dominance Scale.

(3) Statistical Results for the CPI Sociability Scale

Since no significant overall F value is found in

Table XIII for achievement, Hypothesis I-A, I-B and I-C were not rejected. This indicated that levels of achievement were not associated with sociability for the sample studied.

For B (attitude) main effect the significant overall F value indicated that at least one mean was significantly larger than one other. The Newman-Keuls method for testing pairs of means was attempted but a difference could not be detected. The more powerful Student's-t test was then used since in general, the "q" method does not use as much of the information as the "t" test method (Winer, 1962). Table XIV indicates that the high and middle-attitude groups differed significantly in sociability. The high- and low- attitude groups also differed significantly on this scale. However, the low-attitude and middle-attitude group did not differ significantly from one another. Therefore Hypothesis II-A and II-B were rejected but II-C was retained. These results suggest that attitude was distinctly associated with the personality trait, sociability, for the sample under consideration.

(4) Statistical Results for the CPI Communality Scale

Since Table XV indicates that the overall F value is significant for both the A and C main effects, the Newman-Keuls procedure was used to compare pairs of means.

Hypothesis I-A was rejected. The high-achieving

students scored significantly higher on the Communality Scale than did the low-achieving students. Hypothesis I-B and I-C were not rejected. The high-achievers did not differ significantly from the middle achievers and the middle achievers did not differ significantly from the low achievers on the Communality Scale. No evidence to warrant rejection of Hypothesis II-A, II-B or II-C is reported in Table XVI.

An overall F value indicates that there was a significant difference between males and females on the Communality Scale. Inspection of the data indicates that the females scored significantly higher than the males.

(5) Statistical Results for the CPI Flexibility Scale

According to Table XVII, an AC interaction exists. Thus it is valid to interpret the difference for the sexes for each level of achievement separately rather than to interpret the A (achievement) main effect.

Table XVIII indicates that for the low-achievement group the males scored significantly higher than the females on the Flexibility Scale. For the middle-achievement group the situation was reversed. Here the females scored significantly higher in flexibility than did the males. At the highest level of achievement there was no significant difference between the sexes on the Flexibility Scale scores.

This suggests that within and between achievement levels there is a distinct personality trait difference between the sexes as measured by the Flexibility Scale. The graphic representation of Table XVIII is depicted in Figure 1.

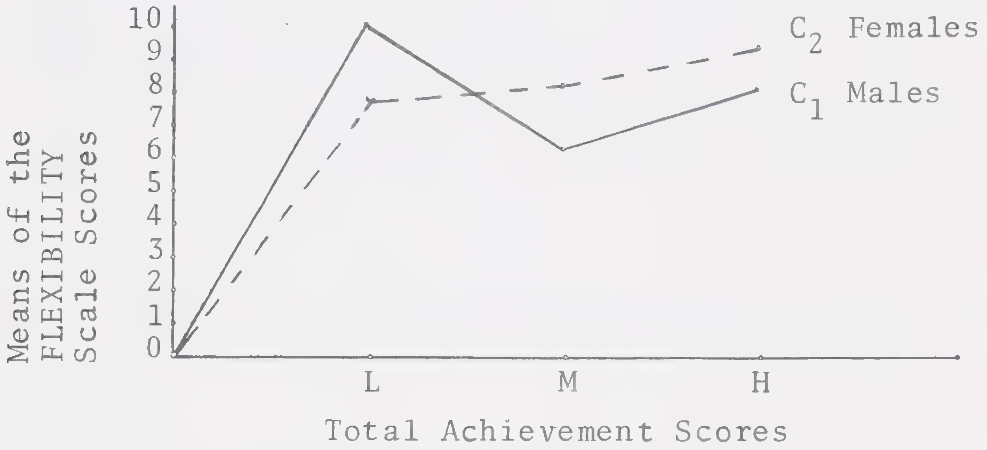
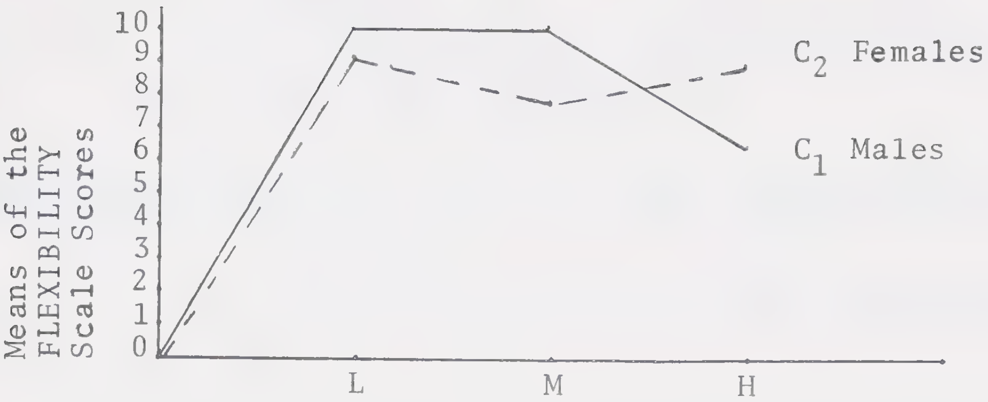


FIGURE 1

INTERACTION BETWEEN ACHIEVEMENT A3 AND SEX ON THE FLEXIBILITY SCALE

Since a BC interaction exists, the analysis of variance for simple effects is given in Table XIX. Figure 2 shows that the male students did not differ significantly from the female students in flexibility at the low and middle-attitude levels. However at the high-attitude level the females scored significantly higher on the Flexibility Scale than did the males.



Attitude to Mathematics Scores

FIGURE 2

INTERACTION BETWEEN ATTITUDE AND SEX ON THE FLEXIBILITY SCALE

(6) Statistical Results for the CPI Femininity Scale

The absence of interaction shows that for all levels of achievement and attitude no difference in psychological masculinity or femininity exists.

Since no overall significant F is found in Table XX for main effects A or B, Hypothesis I-A, I-B and I-C and Hypothesis II-A, II-B and II-C were not rejected. A significant F for the C main effect indicates that the females differed significantly from the males on the Femininity Scale.

It might be noted that within A3, there was no indication that psychological masculinity was associated with higher achievement in mathematics for the sample studied.

V. PART C: EXPERIMENTAL RESULTS USING THE ENTIRE SAMPLE AND ACHIEVEMENT A1

Statistical Results for the CPI Scales: Sc, Do, Sy, Cm, Fx, Fe

(1) Statistical Results for the CPI Self-Control Scale

Table XXI reports no evidence that achievement A1 was related to self-control. Therefore Hypothesis I-A, I-B and I-C were not rejected.

A significant overall F value for the B (attitude) main effect indicates that there are significant differences in the Self-Control Scale scores according to the level of attitude. The Newman-Keuls procedure for comparing pairs of means was used.

Table XXII shows that self-control was related to attitude to mathematics. Specifically it indicates that the high-attitude group and the middle-attitude group both differed significantly from the low-attitude group on the Self-Control Scale. However, the high and middle-attitude groups did not differ significantly from each other on the Self-Control Scale. Therefore the evidence warrants rejection of Hypothesis II-A and II-C but not of II-B.

There was no evidence that males as a group differed from females as a group on the Self-Control Scale. Therefore Hypothesis III was not rejected.

(2) Statistical Results for the CPI Dominance Scale

Table XXIII shows a significant overall F for the main effect A. This indicates that the students within various levels of achievement scored differently on the Dominance Scale. The Newman-Keuls method of testing pairs of means was again used to determine which pairs were significantly different.

Table XXIV indicates that the high achievers within the sphere of A1 were significantly more dominant than the lowest group. The high achievers and middle achievers did not differ significantly from each other on the Dominance Scale nor did the middle and low achievers differ significantly. Therefore the evidence supports rejection of Hypothesis I-A and acceptance of I-B and I-C.

Regarding the B (attitude) main effect evidence supports acceptance of Hypothesis II-A, II-B and II-C. For the sample studied there appeared to be no connection between dominance or submissiveness and attitude to mathematics.

Since no significant overall F value is found for C (sex), this indicates that there was no significant difference between the sexes on the Dominance Scale. Thus Hypothesis III was not rejected.

(3) Statistical Results for the Sociability Scale

The probability is high that the different scores on the Sociability Scale within the achievement levels happened by chance. Thus there was no reason to reject Hypothesis I-A, I-B and I-C. Table XXV indicates achievement A1 was not significantly related to sociability.

Hypothesis II-A, II-B and II-C were also accepted. The statistical data indicate that attitude towards mathematics was not related to sociability in the present sample.

Hypothesis III was also accepted. The data indicate that males as a group did not score significantly differently on the Sociability Scale from the females.

(4) Statistical Results for the CPI Communality Scale

The statistical data in Table XXVI indicate that the levels of achievement differed with respect to scores on the Communality Scale. The Newman-Keuls method was used to compare pairs of means.

Table XXVII indicates that high-achieving students differed significantly from the low-achieving students on the Communality Scale. Hypothesis I-A was therefore rejected but I-B and I-C were accepted.

Since a significant BC interaction occurred, scores on the Communality Scale for the sexes varied for different levels of attitude. The analysis of variance for simple effects was carried out and the results displayed in Table

XXVI of Appendix A.

The test of interaction indicated that the lines as depicted in Figure 3 are not parallel within the limits of random sampling. At the lowest attitude level the females scored significantly higher on the Communality Scale than did the males. At the other two levels of attitude there were no significant differences in the scores. Thus at the lowest attitude level a distinct personality difference was revealed as measured by this scale.

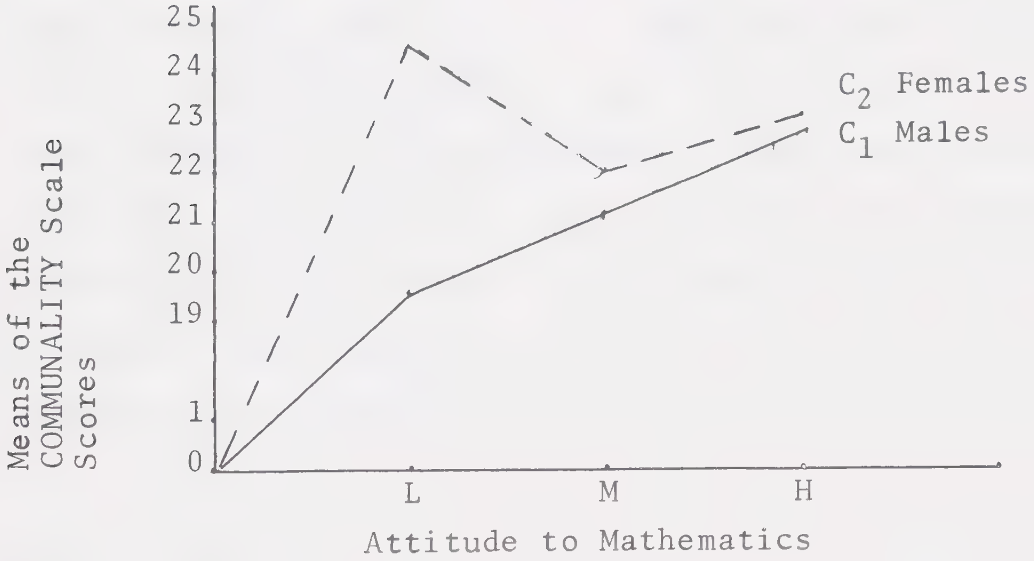


FIGURE 3

INTERACTION BETWEEN ATTITUDE AND SEX ON THE COMMUNALITY SCALE

(5) Statistical Results for the CPI Flexibility Scale

Table XXIX indicates an AC interaction meaning that scores for the sexes varied according to the achievement level. The analysis of variance for simple effects, presented in Table XXX was carried out to determine at which level of achievement significant differences in the Flexibility Scale scores existed.

The test of interaction indicates that the lines in Figure 4 are not parallel in a statistical context. The data show that females at the lowest and middle achievement levels scored significantly higher on the Flexibility Scale than did males at the corresponding achievement level. At the highest level of achievement there was no significant difference in the scores. This suggests that at the lowest and middle achievement levels there could be a distinct personality difference as measured by the Flexibility Scale.

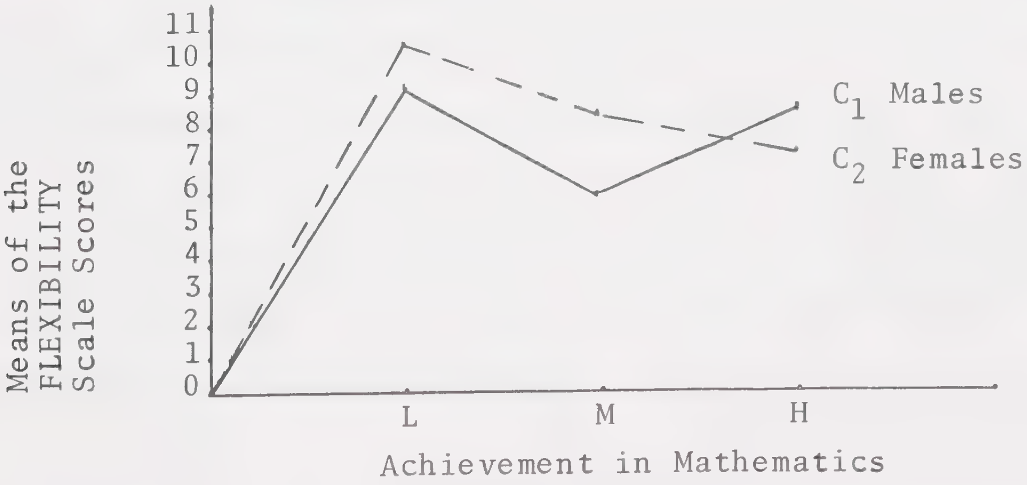


FIGURE 4

INTERACTION BETWEEN ACHIEVEMENT A1 AND SEX ON THE FLEXIBILITY SCALE

The Analysis of Variance results reported in Table XXIX indicate an overall significant F for the B (attitude) main effect. This suggests that true differences in flexibility may occur between levels of attitude. The Newman-Keuls method of comparing pairs of means was attempted but this method could not detect the differences.

Winer (1962) indicated that in most cases the "F" test was more powerful than the corresponding "q" test. Ferguson (1959) showed that when the number of classes is equal to two, that is, when two means are compared at a time, the "t" test is a special case of the "F" test and hence the "t" test is more powerful than the "q" test. The "q" test was more expedient to use when the differences between means could be detected. The powerful "F" test was initially used; hence, there was little chance that significant means would be overlooked. The Student's-t test was used to compare means and the results are reported in Table XXXI.

Table XXXI shows that flexibility was associated with attitude to mathematics. Specifically, the high and middle-attitude group scored significantly differently from the low-attitude group on the Flexibility Scale. However, the high and middle-attitude group did not differ in flexibility. Therefore Hypothesis II-A and II-C were rejected but Hypothesis II-B was accepted.

(6) Statistical Results for the CPI Femininity Scale

The statistical data presented in Table XXXII indicate that there was no association between femininity and achievement A1. Also no relationship was found between attitude and psychological femininity or masculinity. Therefore Hypotheses I-A, I-B, I-C and II-A, II-B and II-C were accepted. Hypothesis III was clearly rejected, as was expected. Lack of interaction indicated that scores on this scale for the sexes did not vary for achievement nor for attitude. No personality difference was apparent, as measured by this scale, between the levels of achievement or attitude.

VI. PART D: EXPERIMENTAL RESULTS USING THE ENTIRE SAMPLE AND ACHIEVEMENT A2

Statistical Results for the CPI Scales: Sc, Do, Sy, Cm, Fx, Fe

(1) Statistical Results for the CPI Self-Control Scale

Hypothesis I-A, I-B and I-C were accepted since no evidence was found to indicate that the scores on the Self-Control Scale were associated with achievement scores at the higher taxonomic level.

Since Table XXXIII shows a significant overall F value on the B main effect, this indicates that there would

be at least one significant difference in the Self-Control Scale scores according to the level of attitude. The Newman Keuls method for comparing pairs of means was used.

Table XXIV indicates that the high-attitude group scored significantly higher on the Self-Control Scale than did the low-attitude group. The middle-attitude group also scored significantly higher than the low-attitude group on this scale. However the high-attitude group did not score significantly differently from the middle-attitude group. Thus Hypothesis II-A and II-C were rejected and II-B was accepted.

Evidence indicates that the sexes did not differ in self-control and thus Hypothesis III was not rejected.

(2) Statistical Results for the CPI Dominance Scale

Table XXXV shows that achievement A2 was not related to dominance. Therefore Hypothesis I-A, I-B and I-C were not rejected.

Table XXXV also shows that attitude toward mathematics scores were not related to the Dominance Scale scores, thus Hypothesis II-A, II-B and II-C were not rejected.

The sexes did not differ on the Dominance Scale and therefore Hypothesis III was not rejected.

(3) Statistical Results for the CPI Sociability Scale

According to Table XXXVI the overall F value for the A (achievement) main effect was not significant. Since

sociability was not associated with achievement A2, there was no reason to reject Hypothesis I-A, I-B or I-C.

A significant overall F value for the B main effect was evident. In order to test the difference between pairs of means the Newman-Keuls method was used.

Table XXXVII shows that the high-attitude group scored significantly higher on the Sociability Scale than did the low-attitude group and the middle-attitude group. The low and middle-attitude group did not score significantly differently from each other. Therefore Hypothesis II-A and II-B were rejected and Hypothesis II-C was accepted.

There was no evidence to indicate that males and females differed significantly on the Sociability Scale. Therefore Hypothesis III was not rejected.

(4) Statistical Results for the CPI Communality Scale

The statistical data in Table XXXVIII indicate that Hypotheses I-A, I-B, I-C and II-A, II-B and II-C could not be rejected. However, Hypothesis III was clearly rejected. Males as a group at this age level clearly differed from the females on the Communality Scale.

(5) Statistical Results for the CPI Flexibility Scale

Table XXXIX shows that levels of achievement within A2, are not associated with scores on the Flexibility Scale. Therefore Hypothesis I-A, I-B and I-C were not rejected.

With respect to Hypothesis II-A, II-B and II-C there is no evidence in Table XXXIX for their rejection. Thus, there was no significant association between levels of attitude and scores on the Flexibility Scale.

In addition, the statistical data do not support rejection of Hypothesis III. No significant difference was found between the sexes on the Flexibility Scale.

(6) Statistical Results for the CPI Femininity Scale

Table XL shows no significant A (achievement) main effect. Thus there was no evidence to warrant rejection of Hypothesis I-A, I-B and I-C. These data also indicate that the students succeeding in problem solving within the sphere of A2 were not more masculine, as a group, than those students of any other achievement level. The present study then does not support Milton's (1957) findings.

There was no evidence on which to reject Hypothesis II-A, II-B or II-C. Attitude to mathematics was not associated with psychological femininity or masculinity.

As to be expected, Hypothesis III was rejected for this scale. Psychological masculinity and femininity were clearly defined at this age level. However, since no interactions were found, there is no indication that at any level of achievement or attitude the sexes varied in femininity or masculinity.

VII. EXPLANATION OF THE APPARENT CONTRADICTION OF FINDINGS ON THE ATTITUDE DIMENSION FOR PARTS B, C AND D

When the entire sample was analyzed, the attitude boundaries which governed entry into high, middle or low-attitude groups, were shifted from boundaries set in Part B (total achievement) to new boundaries in Parts C (achievement within the lower taxonomic level) and D (achievement within the higher taxonomic level) because of the differences in the shapes of the distributions of the achievement scores and the stipulation of equal or proportionate cell frequencies for the Three-Way Analysis of Variance procedure. In order to determine if the results were consistent, it appeared necessary to take the three parts, B, C and D into consideration at the same time. A summary of results presented in Table LXXII of Appendix A is reproduced here for convenience of reference. The results presented below were also substantiated by correlational methods since both methods yielded very similar findings. Comparisons of results for achievement are also presented below.

SCALES SIGNIFICANTLY RELATED TO ATTITUDE FOR PARTS B, C AND D

	Sc	Do	Sy	Cm	Fx	Fe
Part B	*	*	*	X	X	X
Part C	*	X	*	X	*	X
Part D	*	X	X	X	X	X
General Agreement (2 out of 3)	*	X	*	X	X	X

* = significantly related to attitude
X = not significantly related to attitude

Table LXXII indicates that the Self-Control and Sociability Scales appeared consistently related to attitude whereas the Dominance, Communality, Flexibility, and Femininity Scales were not so related.

As mentioned above, correlations were computed in order to substantiate the relationships between attitude and personality traits without consideration of the possible interaction with achievement and sex. The compared results were based on the entire sample. These results indicated that attitude to mathematics was related to self-control ($p = .001$) and to communality ($p = .002$). The self-control relationship appeared consistent by both methods of analyses. When males only were considered using the correlational technique, attitude was related to self-control ($p = .01$) and to communality ($p = .01$); but when females only were considered, attitude was related only to self-control ($p = .03$).

When achievement A3 was considered using the entire sample, there were significant differences on the Dominance as well as on the Communality Scale scores among the levels of achievement.

When the analysis was performed using correlations, achievement was related to dominance ($p = .001$), to communality ($p = .000,01$), and also to sociability ($p = .003$). It thus appears that the Three-Way Analysis of Variance results were accurate to a certain extent but were not as

inclusive of findings as the correlational technique. This discrepancy in results was likely due to the loss of information as a result of the stipulation of equal or proportionate cell membership for the Three-Way Analysis of Variance procedure. However, for the significant differences found, the Analysis of Variance procedure, besides showing interactions, enabled further tests to be carried out which pointed out the association of the scales with specific levels. The writer felt that analyses of specific levels could be more practical in the actual educational setting.

For achievement A1, the Three-Way Analysis of Variance method showed significant differences on the Dominance and Communality Scale scores. The correlational procedure showed achievement within A1 was related to dominance ($p = .002$) and to communality ($p = .000, 002$) but also to sociability ($p = .03$). This gave substantial support to the Three-Way Analysis of Variance procedure.

When achievement A2 was analyzed, the Sociability Scale scores came fairly close to statistical significance ($p = .09$). The correlational procedure related attitude with sociability ($p = .001$) and with dominance ($p = .02$).

VIII. PART E: EXPERIMENTAL RESULTS USING I.Q. STRATIFIED AND ACHIEVEMENT A1, A2

Since 'n' equal to two students per cell would not produce highly reliable results, only two ranges of I.Q. containing the two highest numbers of subjects were analyzed. Also since the results were highly subject to error due to the small 'n', a study of A3 would not clarify the relationships among variables and hence was omitted. Part E of the present study should therefore be viewed with caution since 'n' equal to two was used.

The specific procedure used here was the interpretation of the Three-Way Analysis of Variance results for the six CPI scales for each of the following categories: (1) students in an I.Q. range from 110-120 tested within A1; (2) students in an I.Q. range from 110-120 tested within A2; (3) students in an I.Q. range from 95-109 tested within A1; (4) students in an I.Q. range from 95-109 tested within A2.

It is generally accepted that there are two methods for controlling variability due to experimental error, these being the direct and the statistical methods. Direct control includes methods such as grouping the experimental units into homogeneous strata or blocks. One statistical method of control is called the Analysis of Covariance. Winer (1962) stated that at best covariance adjustments were poor substitutes for direct controls such as stratification.

For this reason stratification into I.Q. groups was carried out and studies of the resultant groups were then undertaken by means of the Three-Way Analysis of Variance procedure.

Analysis of Students in an I.Q. Range From 110-120 Tested Within A1

(1) Statistical Results for the CPI Self-Control Scale

The statistical evidence in Table XLI shows no grounds for rejection of Hypothesis I-A, I-B and I-C, that is, the present study indicates that there was no significant difference in the amount of self-control held by the students when categorized according to the achievement levels.

The data suggest acceptance of Hypothesis II-A, II-B and II-C. This indicates that no significant difference exists in the amount of self-control held by the students in the various attitude levels.

According to the data, males as a group scored consistently lower on the Self-Control Scale than females for all levels of attitudes and all levels of achievement. Hypothesis III was therefore rejected.

(2) Statistical Results for the CPI Dominance Scale

Hypothesis I-A, I-B, I-C, II-A, II-B, II-C and III were clearly accepted. Table XLII indicates that no

significant differences on the Dominance Scale between levels of achievement, attitude or sex were found for the sample under study.

(3) Statistical Results for the CPI Sociability Scale

Table XLIII presents no evidence to reject Hypothesis I-A, I-B and I-C. Thus, for different levels of achievement there was no reason to believe that there were differences in sociability as defined by Gough (1957).

The data reveal a significant difference in sociability scores between the levels of attitude. The Newman-Keuls method was used to determine which means were significantly different.

Table XLIV shows that Hypothesis II-A and II-B must be rejected and that II-C must be accepted. This means that the high-attitude group differed significantly from both middle-attitude and low-attitude groups in sociability. Also the middle-attitude and low-attitude group did not differ significantly on the Sociability Scale.

Hypothesis III was accepted. Males, as a total group from all attitude levels and all achievement levels, were not significantly different in sociability from females as a total group.

(4) Statistical Results for the CPI Communality Scale

The data reveal evidence sufficient to warrant acceptance of Hypothesis I-A, I-B and I-C. Table XLV indicates no significant difference between any of the achievement levels on the Communality Scale scores.

Since the data indicate an overall significant F value on the B main effect, the Newman-Keuls method for comparing pairs of means was used. The results are reported in Table XLVI.

Table XLVI shows that the high-attitude group scores were significantly higher than the low and middle-attitude group scores on the Communality Scale. Thus Hypothesis II-A and II-B must be rejected and II-C must be retained.

The significant difference for the sex categories indicates that one must reject Hypothesis III. The data suggest that at this age level the males are significantly lower than the females in socialization, maturity and responsibility.

(5) Statistical Results for the CPI Flexibility Scale

The data indicate that one cannot reject Hypothesis I-A, I-B and I-C. Flexibility did not appear to be associated with achievement Al.

Table XLVII shows that the personality trait,

flexibility, was associated with the levels of attitude. Since the overall F value was significant, the Newman-Keuls method for comparing pairs of means was used.

Table XLVIII indicates that one must accept Hypothesis II-B and II-C, but reject II-A. That is, students with high attitudes to mathematics possess significantly different (lower) scores on the Flexibility Scale than students of low attitudes. However, acceptance of Hypothesis II-B and II-C means that the low and middle-attitude groups did not differ significantly in flexibility and neither did the middle and high groups.

Hypothesis III was accepted. Females did not differ significantly from males on the flexibility dimension.

(6) Statistical Results for the CPI Femininity Scale

The data indicate acceptance of Hypothesis I-A, I-B and I-C. There was no reason to suspect that any level of achievement in mathematics within this taxonomic level (A1) was related to psychological femininity.

Attitude to mathematics was not linked to psychological femininity or masculinity. Therefore Hypothesis II-A, II-B and II-C were also accepted.

As expected, Table XLIX indicates rejection of Hypothesis III.

Analysis of Students in an I.Q. Range from 110-120 Tested Within A2

(1) Statistical Results for the CPI Self-Control Scale

Table L shows that achievement A2 was not associated with self-control. Thus Hypothesis I-A, I-B and I-C were accepted.

Since a significant overall F is present, the Newman-Keuls method was used to determine which pairs of means were significantly different from one another. Table LI shows that one must reject Hypothesis II-A and II-C, and accept II-B. The students with low attitudes differed significantly from the students of both high and middle attitudes on self-control. This table therefore indicates that certain levels of attitude were linked to the personality trait of self-control in the subjects tested.

Hypothesis III must be rejected. The data show that the overall F value was significant. Thus males scored significantly differently from females on the Self-Control Scale irrespective of attitude to mathematics or achievement in mathematics.

(2) Statistical Results for the CPI Dominance Scale

There was no indication that achievement A2 was related to dominance. Thus Hypothesis I-A, I-B and I-C must be accepted.

The data also show no significant overall F for the B main effect, thereby indicating that there were no real differences in dominance among the levels of attitude. Thus Hypothesis II-A, II-B and II-C were not rejected.

Table LII also indicates that regardless of the attitude level or achievement level there appeared to be no real difference in degree of dominance held by males or females. Therefore Hypothesis III was not rejected.

(3) Statistical Results for the CPI Sociability Scale

The overall F value for the A main effect is not significant, as indicated in Table LIII. Levels of achievement within A2 were not associated with sociability and Hypothesis I-A, I-B and I-C were therefore accepted.

A significant overall F indicates statistical differences in means for the B main effect. The Newman-Keuls technique for comparing means was used and the results compiled into Table LIV.

Table LIV shows that students with high attitudes and students with middle attitudes toward mathematics were significantly higher in sociability than students with low attitudes. Students with middle attitudes toward mathematics were not significantly different in sociability from students with high attitudes. Thus one must reject Hypothesis II-A and II-C and accept Hypothesis II-B.

No evidence emerged to suggest that males scored significantly differently on sociability than females. Thus Hypothesis III was not rejected.

(4) Statistical Results for the CPI Communality Scale

Since the overall F is not statistically significant, there was no reason to believe that the personality trait, communality, was associated with any of the levels of achievement. Hence one must accept Hypothesis I-A, I-B and I-C.

Since the overall F is significant for the B main effect as Table LV shows, the means for the three levels of attitude were compared by the Newman-Keuls method.

Table LVI indicates that attitude was linked to the personality trait, communality. Significant differences in Communality Scale scores between high-attitude and low-attitude groups as well as between high-attitude and middle-attitude groups were found to exist. There was no significant difference on the Communality Scale scores between the middle-attitude and low-attitude groups.

Since the overall F was significant on the C main effect, this showed that males differed significantly from females on the Communality Scale scores regardless of their attitude toward mathematics or their achievement in it.

(5) Statistical Results for the CPI Flexibility Scale

Table LVII shows that there is no evidence to reject Hypothesis I-A, I-B and I-C. It appeared that flexibility was not associated with achievement A2.

Hypothesis II-A, II-B and II-C were also accepted. There was no association between any of the levels of attitude and flexibility.

Since the overall F is not significant for the C main effect, Hypothesis III was not rejected. Therefore males as a group did not differ from females in flexibility.

(6) Statistical Results for the CPI Femininity Scale

Since the overall F is not significant for the A main effect, Hypothesis I-A, I-B and I-C were accepted.

Since the data indicate no significant F on the B main effect (attitude), there was no reason to reject Hypothesis II-A, II-B and II-C. Therefore Table LVIII indicates there were no grounds for suggesting that any level of attitude to mathematics was associated with femininity or masculinity.

As expected, Hypothesis III was clearly rejected for this scale.

Analysis of Students in the I.Q. Range 95-109 Tested Within A1

(1) Statistical Results for the CPI Scales: Self-Control, Dominance, Sociability, Communality

Since the overall F is not significant for the main effect A (achievement) for each of the scales: Self-Control, Dominance, Sociability and Communality, there was no reason to reject Hypothesis I-A, I-B and I-C for each scale. This means that for no level of achievement did the students differ significantly in self-control, dominance, sociability, or communality. The results of the analyses are presented in Tables LIX through LXII.

Since the data indicate no significant F on the main effect B, for each of the scales: Self-Control, Dominance, Sociability and Communality, there was no reason to reject Hypothesis II-A, II-B and II-C. This means that for no level of attitude did the students differ significantly in self-control, dominance, sociability or communality.

There was no reason to reject Hypothesis III for each of the Self-Control, Dominance, Sociability and Communality Scales.

(2) Statistical Results for the CPI Flexibility Scale

Since Table LXIII indicates a significant AC interaction, an analysis of variance for simple effects was

executed. The results are presented in Table LXIV. Figure 5 is a graphical representation of the results of the analysis.

Since an AC interaction effect was found, this meant the Flexibility Scale scores for each sex varied as the achievement level increased. Analysis of simple effects indicates that for the low achievement category males were significantly higher in flexibility. When high achievement was considered, the situation was reversed: females were significantly higher in flexibility than males. For the middle level in achievement no significant difference between means emerged, so there was no reason to suggest that males differed from females in flexibility at this level.

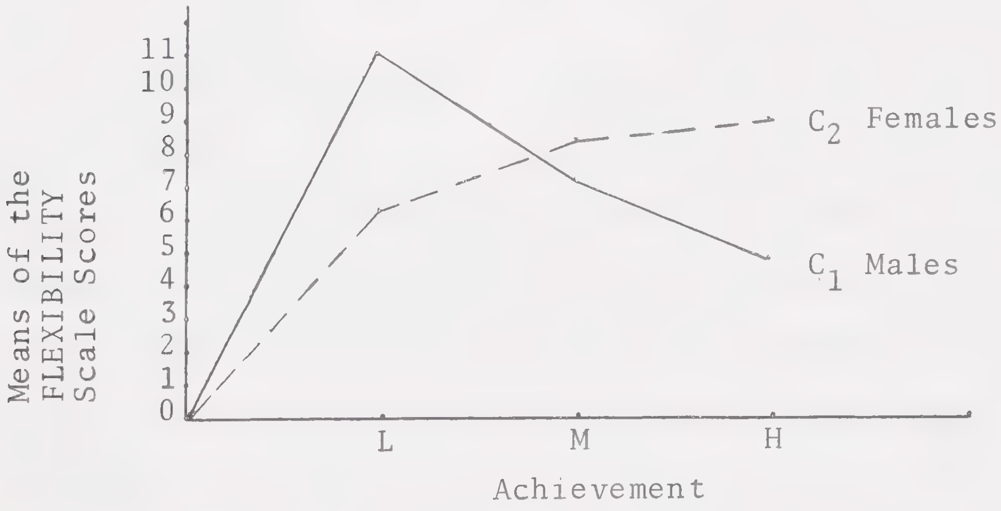


FIGURE 5

INTERACTION BETWEEN ACHIEVEMENT A1 AND SEX ON THE FLEXIBILITY SCALE FOR I.Q. RANGE 95-109

Since an AC interaction was found, it is valid only to interpret the interaction showing the variation of scores for factor C for levels of A rather than to analyze the main effects (Winer, 1962).

Since the overall F is nonsignificant for the B main effect and since there is no interaction effect involving B, it appeared that the personality trait, flexibility, was not related to any attitude level. Therefore Hypothesis II-A, II-B and II-C were accepted.

Hypothesis III was also accepted. Males and females apparently did not differ in flexibility.

(3) Statistical Results for the CPI Femininity Scale

Since the overall F value is not significant for the A main effect, there was no reason to believe that levels of achievement in mathematics were associated with femininity and Hypothesis I-A, I-B and I-C were accepted.

Hypothesis II-A, II-B and II-C were also accepted. There is no indication in Table LXV that femininity was associated with attitude to mathematics.

As expected, Hypothesis III was rejected. This indicated that males as a group differed significantly from females in masculinity. This role identification appears consistently through all the I.Q. levels.

Analysis of Students in the I.Q. Range 95-109 Tested Within A2

(1) Statistical Results for the CPI Scales: Self-Control, Dominance, Sociability, Communality, Flexibility, and Femininity

Tables LXVI through LXXI indicate that each of the scales: Self-Control, Dominance, Sociability, Communality, Flexibility, and Femininity, were not associated differentially with achievement in mathematics when I.Q. was held in the narrow range of 95-109. Therefore Hypothesis I-A, I-B and I-C were not rejected for any of the scales.

Since there is no significant F value for the B main effect for any of the personality scales, Hypothesis II-A, II-B and II-C were not rejected.

Hypothesis III was rejected for the Femininity and Communality Scales. This indicates that even when the I.Q. was held in a narrow range, females differed (significantly higher) on the Communality Scale scores from the males.

IX. PART F: EXPERIMENTAL RESULTS OF THE STEPWISE REGRESSION ANALYSIS

Hypothesis IV and V were tested by the Stepwise Regression Analysis. The hypotheses to be tested are restated here for reference.

Hypothesis IV

The efficiency of prediction of mathematics achievement scores of grade eight students over and above general intelligence is not significantly improved by adding scales on:

(a) attitude to mathematics

(b) personality

 (1) Self-Control
 (2) Dominance
 (3) Sociability
 (4) Communality
 (5) Flexibility
 (6) Femininity

Hypothesis V

The efficiency of prediction of attitude to mathematics scores of grade eight students is not significantly improved by scales on:

(a) general intelligence

(b) personality

 (1) Self-Control
 (2) Dominance
 (3) Sociability
 (4) Communality
 (5) Flexibility
 (6) Femininity

(c) achievement within

 (1) A1
 (2) A2
 (3) A3

(1) Statistical Results for the Prediction of Achievement A1

The prediction of achievement A1 was attempted using eight predictors: Attitude to Mathematics, I.Q., Self-Control,

Dominance, Sociability, Communality, Flexibility and Femininity. Table LXXIII shows that the Communality and Attitude Scales significantly improved prediction over and above general intelligence. Parts a and b(4) of Hypothesis IV were thus rejected. The equation that would give the best prediction of a score at this taxonomic level is given in Table LXXIII. This table shows that besides general intelligence, communality and attitude were related to achievement within A1.

(2) Statistical Results for the Prediction of Achievement A2

The prediction of achievement A2 was also attempted by using eight predictors: Attitude to Mathematics, I.Q., Self-Control, Dominance, Sociability, Communality, Flexibility and Femininity. The Attitude and Sociability Scales significantly improved prediction over and above general intelligence when the criterion was achievement A2. Therefore parts a and b(2) of Hypothesis IV were rejected. The significant contributions of attitude and sociability to prediction over and above general intelligence are found in Table LXXIV. This means that besides general intelligence attitude to mathematics and sociability are related to achievement within A2.

(3) Statistical Results for the Prediction of Achievement A3

The prediction of achievement A3 was attempted using eight predictors: Attitude to Mathematics, I.Q., Self-Control, Dominance, Sociability, Communality, Flexibility and Femininity. Table LXXV indicates that when achievement is considered within A3, parts a and b(4) of Hypothesis IV are rejected. Achievement could be better predicted by using the Attitude and Communality Scales rather than using I.Q. scores alone. The best prediction is given by the equation presented in Table LXXV. This means that besides general intelligence attitude and communality are related to achievement within A3.

(4) Statistical Results for the Prediction of Attitude

An attempt was made to predict attitude to mathematics using ten predictors: Achievement (A1, A2, A3), I.Q., Self-Control, Dominance, Sociability, Communality, Flexibility and Femininity. Table LXXVI indicates that Hypothesis V parts b(3), b(4), b(5) and c(3) are to be rejected. The variables: achievement (A3), self-control, communality and flexibility all contributed significantly to predicting attitude to mathematics. The best fitting equation for determining attitude to mathematics is presented in Table LXXVI. The results indicate that success, self-control, communality and flexibility are related to positive attitudes toward

mathematics.

It is of interest to note that I.Q. did not aid in the prediction of attitude, and that self-control accounted for the second largest share of the attitude variance.

CHAPTER VI

CONCLUSIONS, INTERPRETATIONS AND IMPLICATIONS FOR FURTHER RESEARCH

I. THE AIMS OF THE STUDY

One of the aims of this study was to clarify the relationship among the variables: personality (using six selected dimensions), achievement in mathematics, attitude toward mathematics, and sex. Information was sought with regard to the interaction of these factors as well as the association of the selected personality traits with levels of these factors. Since grouping or categorization of students into levels is still a necessary administrative task, knowledge of personality patterns within groups and among groups of students would likely be of value to those persons associated with mathematics learning. A study of the interactions among variables appeared important since the results of any interactions found within this present study could possibly serve as a basis for differentiated instruction and materials.

Another purpose of the study was to assess the importance of selected personality traits in predicting mathematics performance and attitude toward mathematics.

The educational setting for which this study is valid may be described as the traditional classroom scene which

generally consists of one teacher per classroom, one or two textbooks per student, and a brief lecture and question period followed by a work session.

Gough's description of the personality traits is included in Chapter III. Brief references from the main descriptions are consistently used within the present chapter.

A reading of the related literature indicated that achievement is related to personality traits (Neale, 1969), that attitude toward mathematics is related to the personality traits of the student (Aiken, 1963), and that problem solving is related particularly to psychological masculinity and femininity (Milton, 1957). These findings suggested a need to study the relationships among the personality, achievement, attitude, and sex variables in greater depth in order to determine their roles in the educational process within the field of mathematics.

II. PERSONALITY VARIABLES AS RELATED TO INTELLIGENCE

The analyses in Part A showed that the scales: Dominance, Sociability, Communality and Flexibility were significantly related to general intelligence while the Self-Control and Femininity Scales were not related to general intelligence. However, the Femininity Scale approached significance ($p = .05$) at the 0.05 level. The

above results tended to suggest that grouping of students according to general intelligence might provide somewhat homogeneous groups with regard to dominance, sociability, communality and flexibility. Since outward behavior would appear to be associated with self-control, such a class or group would on the surface appear heterogeneous since self-control would not be the basis for grouping.

The analyses in Part A also showed that when the I.Q. range 84-94 was analyzed, there were no personality variables related to mathematics achievement nor to attitude. When I.Q. range 95-109 was analyzed, there were no personality variables related to achievement but self-control was related to attitude toward mathematics. When the I.Q. range 110-120 was tested, communality was related to achievement in all three categories, A1, A2 and A3, while sociability and communality were related to attitude. Flexibility was negatively associated with attitude. For the I.Q. range 121-136, self-control was related to achievement within the higher taxonomic level, A2, and dominance was related to achievement within the lower taxonomic level, A1, as well as to achievement considered within the taxonomic levels combined, A3. Self-control was related to attitude toward mathematics.

This indicates that personality plays a significant role beyond general intelligence in mathematics learning. The results above also suggest which personality traits

might be prerequisites for mathematics learning and for the development of positive attitudes toward mathematics when intelligence levels are considered. The Stepwise Regression Analysis indicates the personality traits which are related to mathematics learning and positive attitudes when levels are not taken into account.

Part A indicates that when classes in mathematics are grouped within I.Q. ranges 84-94 or 95-109, the teacher may expect that in the present school setting these students are still somewhat homogeneous with respect to the personality traits, and that the students who score higher on the scales do not necessarily score higher in mathematics. If the classes are composed of students within the I.Q. range 110-120, the teacher may expect within our present educational setting that students more developed in socialization, maturity and capacity for responsibility will attain higher mathematics scores on tests requiring both the lower mental processes and the higher mental processes as tested within the two corresponding taxonomic levels. This appears to suggest that within our educational setting the impatient, imaginative, disorderly, nervous, restless, forgetful and inattentive person who may have internal conflicts and problems can be expected to achieve poorly in modern mathematics. If the classes are composed of students within the I.Q. range 121-136, the teacher may expect the students with higher self-control to achieve better within the

taxonomic level using the higher mental processes than the students with the same general intelligence but without this personality trait. The more dominant students would very likely achieve higher within the lower taxonomic category. This tends to suggest that the aggressive, confident and persistent students would attain higher scores at the Knowledge, Comprehension and Application taxonomic level.

It would appear that a different educational setting might be required for those students lacking the required personality traits. Since self-control consistently appeared related to attitude, the data suggest that within our present educational setting those persons who are by nature calm, patient and inhibited developed more favorable attitudes to mathematics than those persons who tend by nature to be impulsive, excitable, irritable, uninhibited or aggressive. It may be that a different setting not requiring a high degree of self-control may complement the students with less self-control and thus produce a positive attitude to mathematics.

Stepwise Regression Analysis pointed out those personality traits that appear to be related to mathematics achievement and to positive attitudes toward mathematics without taking any specific general intelligence level into account. Much the same overall results were found.

In order to succeed in mathematics at the Knowledge,

Comprehension and Application taxonomic level, beyond being endowed with general intelligence the personality trait of communality and attitude to mathematics, in that order, were suggested by the data to be significantly related to mathematics achievement at this level. The students who are impatient, imaginative, disorderly, nervous, restless, inattentive or those who have internal conflicts or problems would likely achieve lower at this lower taxonomic level. If the student already has a poor attitude, he would likely achieve still more poorly. Since it will be suggested further on in this development that the data indicate that attitude appears to be highly related to success and to self-control, it appears that the students not bringing this type of personality to the mathematics classroom will not achieve as highly as ones who possesses these traits.

The result may be interpreted as supporting a free-climate concept of the school in which the student according to his or her aptitude and personality, is allowed to choose among a large variety of meaningful materials and procedures to formulate a flexible program and thereby build a success pattern based on choices more likely in line with his ability, interest and personality.

When achievement within the Analysis and Synthesis Levels is analyzed, attitude to mathematics (which is related to success or failure and self-control) and sociability each

play significant roles above that of general intelligence. This means that students who are low in sociability, that is, those who are quiet, submissive, passive and easily influenced by other opinions do not succeed in problem solving, the taxonomic level corresponding to the highest mental processes. This may mean within our present educational setting the student not specifically possessing this personality trait will not achieve as well as the student possessing it even though the two are closely matched in general intelligence. This suggests, in problem solving the out-going student who demands required pertinent information from materials, other students, or from teachers for the solution of the problem, is more likely to be the student who succeeds. The shy, quiet, submissive student, even when high general intelligence is present, is more likely to falter. This appears to indicate a system of mathematics teaching where either the student in lower grades is made more sociable or it may mean a system where the quiet, submissive student is helped to achieve well in his own way. Perhaps individualized instruction or a free-climate school with a variety of meaningful materials and approaches combined with a flexible program would enable these students to circumvent situations requiring a high degree of sociability.

With regard to the relationship of attitude toward mathematics, there are several important factors to be

considered. Evidence exists in the Appendix to suggest that high achievement (the success-failure dimension) is related to attitude. The second relevant factor is self-control. It appears that those students who possess self-control to a greater degree also appear to have positive attitudes. Another significant related scale is communality. The dependable, moderate, reliable, patient and steady person (as opposed to the impatient, disorderly, nervous, restless person who may have internal conflicts and problems) is also more likely to have a positive attitude to mathematics. Last, flexibility plays a significant role in relation to attitude. The students who are less flexible are likely to possess higher attitude scores. This may mean that the person who consistently brings to the mathematics situation a personality which is insightful, informal, adventurous, rebellious, sarcastic and assertive will be more likely to leave with a negative attitude to mathematics. A person who is cautious, worrying, rigid, and overly submissive to authority, custom and tradition tends to develop a positive attitude toward mathematics. The above result may indicate that student adjustment by student choice from a variety of meaningful choices could result in a higher attitude to mathematics and higher achievement in it.

III. PERSONALITY VARIABLES AS RELATED TO ATTITUDE AND ACHIEVEMENT LEVELS

The Analysis of Variance procedure provided the following results. "Differed" means "differed significantly at the 0.05 level."

Part B

Summary of results for the entire sample, for taxonomic levels combined (A3):

Sc The high-attitude group differed from the low-attitude group on the Self-Control Scale. No other combination of levels differed.

Do The high-achievement group differed from the low-achievement group on the Dominance Scale. No other combination differed. The high-attitude group differed from the low-attitude group on the Dominance Scale. No other combination differed.

Sy The high-attitude group differed on the Sociability Scale from the low and middle-attitude groups. The other combinations of levels did not differ.

Cm The high-achievement group differed from the low-achievement group on the Communality Scale.

No other combination differed.

The sexes differed on this scale.

Fx A sex-achievement interaction existed on the Flexibility Scale. The low-achieving females were second highest on the Flexibility Scale. The middle-achieving males were the least flexible.

A sex-attitude interaction was present on the Flexibility Scale. The low and middle-attitude males were equally the most flexible. The high-attitude males were the least flexible.

Part C

Summary of results for the entire sample, for the lower taxonomic level, A1, (Knowledge, Comprehension, and Application):

Sc The high and middle-attitude groups differed from the low-attitude group on the Self-Control Scale. The high and middle-attitude groups did not differ from one another.

Do The high-achieving group differed from the low-achieving group on the Dominance Scale. No other combination differed.

Sy There were no significant results on the Sociability Scale.

Cm The high-achieving group differed from the low-achieving group on the Communality Scale. No other combination differed.
A sex-attitude interaction was present. The low-attitude females had the highest Communality Scale scores. The high-attitude females had the second highest Communality Scale scores. The low-attitude males had the lowest scores.

Fx A sex-achievement interaction was present on the Flexibility Scale. The highest Flexibility Scale scores were gained by the low-achieving females. The lowest Flexibility Scale scores were gained by the middle-achieving males.
The high-attitude group differed in Flexibility Scale scores from the low group. No other combination of levels differed.

Fe As expected, a sex difference was found to exist on the Femininity Scale.

Part D

Summary of results for the entire sample, for the highest taxonomic level, A2, (Analysis and Synthesis):

Sc The high and middle-attitude groups differed from the low-attitude group on the Self-Control

Scale. The high and middle groups did not differ.

Do There were no significant results on the Dominance Scale.

Sy The high-attitude group differed from both the low and middle-attitude groups on the Sociability Scale.

Cm There was a sex difference on this scale.

Part E-1

Summary of results for I.Q. range 110-120 for A1 (Knowledge, Comprehension and Application taxonomic level):

Sc There was a sex difference on this scale.

Do There were no significant results on this scale.

Sy The students with high-attitudes scored significantly higher than the middle and the low-attitude groups on this scale. The other combinations of levels did not differ.

Cm The students with high attitudes scored significantly higher than the middle and the low-attitude groups on this scale. The other combinations did not differ. The sexes differed on this scale.

Fx The high-attitude students differed from the low-attitude students on this scale. No other combination differed.

Fe As expected, a sex difference was found on this scale.

Part E-2

Summary of results for the I.Q. range 110-120 for A2 (Analysis and Synthesis taxonomic level):

Sc The high and middle-attitude groups were each significantly higher on the Self-Control Scale when compared to the low-attitude group. The high and middle-attitude groups did not differ.

Do There were no significant results on this scale.

Sy The high-attitude and middle-attitude groups differed from the low-attitude group on this scale. The middle and high-attitude groups did not differ.

Cm The high-attitude group differed from the low and middle-attitude group on this scale. The middle and low-attitude groups did not differ.

Fx There were no significant differences on this scale.

Fe There was a sex difference on this scale as was expected.

Part E-3

Summary of results for the I.Q. range 95-109 for A1 (Knowledge, Comprehension and Application taxonomic level):

Fx An AC interaction was present. The males at the low-achievement level were the most flexible; second in flexibility were the females at the high-achievement level; the low scores in flexibility were obtained by the males of the high-achievement level.

Fe As expected, the sexes differed on this scale.

Part E-4

Summary of results for the I.Q. range 95-109 for A2 (Analysis and Synthesis taxonomic level):

Sc, Do There were no significant differences on
Sy, Fx these four scales.

Cm, Fe There were sex differences on these scales.

The present study indicates, when the entire sample was analyzed, attitude to mathematics was related to self-control and to communality. The self-control relationship emerged from both methods of analyses, the Three-Way Analysis of Variance and the Correlational method. When males only

were considered in the correlational analysis, attitude was related to self-control and to communality, but when females only were considered attitude was related only to self-control.

When achievement A3, (all taxonomic levels combined) was considered using the entire sample, there were significant differences among mathematics achievement levels on the Dominance and Communality Scales. When an analysis was performed using correlations, achievement was again found to be related to dominance and to communality as well as to sociability. It thus appears that the Three-Way Analysis of Variance results, although accurate as stated, were not as inclusive as the results obtained from the correlational technique. However, for the significant findings the Analysis of Variance method enabled further tests to be carried out to indicate which specific levels differed. Interaction effects were also identified.

For achievement category A1, achievement within the Knowledge, Comprehension, and Application taxonomic level, the Three-Way Analysis of Variance method yielded significant differences on the Dominance and Communality Scale scores. The correlational procedure indicated that achievement within the taxonomic framework described was related to dominance and to communality but also to sociability. This provided substantial support to the Three-Way Analysis of Variance results.

When achievement, A2, within the Analysis and Synthesis taxonomic level framework was analyzed, the Sociability Scale scores came close to significance (p = .09). The correlational procedure related attitude with sociability and with dominance.

If substudies parts B, C and D in which the entire sample was analyzed, are examined, it is evident that significant differences in self-control and sociability were consistently found between the attitude levels. The high and middle-attitude groups differed consistently from the low-attitude group on the Self-Control Scale. With equal consistency, the high and middle-attitude groups did not differ in scores on the Self-Control Scale. This seems to indicate that when levels, classrooms, or groups are important, teaching the low-attitude class may require different materials, techniques, and curricula because of the corresponding (lower) self-control factor.

With respect to sociability, when groups or classes are important in teaching, there appears to be consistent evidence that the high-attitude group differed from the middle and low-attitude group on sociability but that the middle and low-attitude group did not differ from one another. This may indicate that in teaching middle or low-attitude students one should use procedures which do not place a high demand on sociability. For the high-attitude group or class, procedures, materials and techniques which

require high sociability may be emphasized.

When scores of achievement were taken as a cross-section of every taxonomic level, A3, representing a sample of all levels of mental processes, the high-achievement group differed from the low-achievement group on the Dominance and Communality Scales. The middle group did not differ from the low or the high group. This tends to suggest that the high achievers could be expected to be aggressive, confident, persistent and dependable. Since the literature indicates that the process of mathematics will tend to be preparation in creative processes necessary for solving problems which are unforeseen at the present time, the personality of the high achievers suggests that for this group productive learning through discovery might be feasible. Teacher-taught classrooms as found at present might well be unnecessary for this group. On the contrary, students of low achievement may not have the necessary personality traits to persist independently since as a group they differed significantly in dominance and communality. On the whole, these students might be regarded as inhibited, indifferent, slow in thought and action, avoidant of situations of tension and decision, impatient and disorderly. It appears the low-achievement group would have to be carefully led, perhaps in such teacher-taught classrooms as found at present. A sex-achievement interaction was present on the Flexibility Scale. The low-achieving males scored

highest and the high-achieving females scored second highest on the Flexibility Scale. This appeared to show that these two groups are similar in they tend to be insightful, informal, adventurous, confident, rebellious, idealistic, sarcastic and cynical. This may suggest that in mathematics project work requiring a high degree of creativity and flexibility, grouping of the low-achieving males with the high-achieving females might provide a promising group for creative work. However, teacher guidance may be required for orderly development. The other groups, not appearing to be as flexible, but possibly more cautious, industrious and methodical would perhaps produce finished projects in more orderly and formal style. The middle-achieving males were the least flexible and as a result might require more extensive guidance in creative projects or tasks.

Similar findings as for the combined levels cited above were found for the lower taxonomic level. With respect to achievement within the lower taxonomic level (Knowledge, Comprehension and Application) the high-achieving group scored significantly higher on the Dominance and Communality Scales than the low-achieving group. The middle group did not differ significantly from the high or low group. This appears to indicate that the teacher could expect classes of high achievers to be aggressive, persistent and independent as well as dependable, patient, conscientious

and prone to have good judgement while expecting low-achieving classes to be indifferent, silent, lacking in self-confidence, as well as impatient, disorderly, restless, nervous, inattentive and forgetful. This dichotomy in expectation should possibly be balanced by suitable educational procedures and programs as well attempts to provide confidence-building experiences. The study being reported supports the concept of classes, designated as transitional, adjustment, pre-employment or by some other suitable phrase,which account and provide for the personality of the individual as well as for his low general intelligence.

For achievement A2, the Analysis and Synthesis taxonomic level corresponding to the highest level of mental process in mathematical thought, no personality scales emerged which were associated with levels of achievement. However, the Stepwise Regression Analysis procedure using all of the available data indicate that sociability plays a significant role. The Three-Way Analysis procedure did not uncover this scale, possibly due to the loss of data resulting from the requirement of equal or proportionate cell membership which needed to be met.

Females consistently scored higher than males on the Communality Scale. This suggests that females at this age level may be more dependable, moderate, reliable, patient and conscientious than their male counterparts.

Since this scale was found by the Stepwise Regression procedure to be a significant predictor over and above general intelligence for mathematics learning, some support is obtained for the suggestion that different procedures and methods, and perhaps incorporating materials with mathematical applications likely to interest females be used to enhance attitude change and achievement gain.

As indicated previously, when general intelligence was held constant in Part E of the study, the Three-Way Analysis of Variance procedure did not yield some of the significant scales that emerged from the other procedures. Since only a small number of subjects per cell was available for use, Part E should be viewed with caution. Results from Pearson product-moment correlations and the stepwise regression analysis which used all the available data should be employed as indicators of the personality effects over and above general intelligence. However, attitude to mathematics was shown by all three methods of analysis to be related to self-control, communality and flexibility. The consistency of this result suggests that the personality brought into the present mathematics classroom may bear a significant part in the attitude developed toward mathematics. It appears very important that students who do not possess these personality traits and also, as indicated by the Stepwise Regression Analysis method, those students who have a consistent failure record be initiated

into a mathematics program more appropriate to their personality. Success in the formation of such a program might ultimately break the cycle of failure stemming from personality maladjustment and result in positive attitudes and possibly higher achievement gains.

Some of the above results are in agreement with findings by previous researchers. In Part B of the study it was found that when the entire sample was studied, the high-achievers scored significantly higher in dominance than the low achievers. An analysis within the high-achieving group was performed. The data reveal that for the I.Q. range 110-120 at the Knowledge, Comprehension and Application level, an AC interaction was present (p = .098) for achievement and sex on the Dominance Scale. Analysis of the data indicate much the same result as found by Neale (1969), namely that submissive students achieve better, with the females being more submissive than males at this high-achievement level. At the middle level of achievement the females were more dominant than the males. The middle-achieving females were also more dominant than any other group for any level. For the low-achieving students the males were more dominant than the females with the females being extremely submissive. The males at this low-achievement level were more dominant than any other group of males at any other level. This suggests that submissiveness appears to be related to high achievement within the sample analyzed.

A result similar to that reported by Aiken (1963) was found in the relationship of self-control to attitude. When the effects of mathematical ability were partialled out, Aiken found the CPI Dominance and the CPI Self-Control Scales were still significantly associated with attitude to mathematics. The significant result on the Dominance Scale might have been due to the different age level of the subjects analyzed.

Fair (1959), in his study of college students, found a significant correlation between the Flexibility Scale and achievement. However, this correlation was low and negative. When the entire sample within the present study was analyzed, no association of flexibility with achievement for any achievement category emerged.

There was no indication at any I.Q. level that high problem-solving ability was associated with masculinity at this age level. When the Femininity Scale was analyzed for levels of problem solving, the superior problem solvers were not found to have significantly lower scores on the Femininity Scale. In addition, no significant differences emerged for any other taxonomic level. The result does not lend support, at least for this age level, to Milton's (1957) study, which found that masculine identification was associated with higher problem-solving scores. However, Milton's subjects were college students.

IV. CONCLUSION

Although a primary aim of the present study was to determine if personality traits were associated with mathematics learning over and above general intelligence, one of the procedures employed was the Stepwise Regression Analysis which yielded variables acting as statistically significant predictors. These factors were then used, not so much for prediction, but for their value in determining if certain personality variables do in fact contribute to mathematics achievement at this grade level over and above general intelligence. The same procedure was used to ascertain those personality factors which are significantly related to attitude.

The present study indicates that certain personality traits are indeed related to mathematics learning and to positive attitude formation. Various experimental school settings may require different personality traits for optimal functioning within the new system. Investigation into such associated traits would appear fruitful to all concerned with mathematics learning; the student, the teacher, the parents, and the guidance counselor.

V. IMPLICATIONS FOR FURTHER RESEARCH

Since the Self-Control Scale was found to be significantly associated with attitude to mathematics, a

study should be undertaken to determine if different school settings and procedures, as well as policies which do not demand high self-control, would produce positive attitudes. As an extension of the study cited, comparative studies should be undertaken to determine whether or not different students within experimental schools require personality traits over and above general intelligence which differ from the ones found here in order to perform well. It is at least a possibility that certain instructional settings may require certain personality traits in the student in order that he adapt optimally to it.

Consistent research over the school years could be carried out to determine if any personality trait contributes or detracts from achievement. A similar study could be done with respect to attitude. Such investigations would determine if there were any marked changes from year to year, grade to grade, or school to school.

Research should be conducted in order to determine if materials can be written which are suited to certain personality traits. The consistency of approach by students (cognitive style, which the writer believes is very closely linked to personality) to materials that complement this style might produce higher attitudes and achievement. Similar studies should be carried out to explore the possibility that different materials be written for males and females. Differences in psychological femininity,

capacity for responsibility and sociability suggest room for differential instructional materials and techniques. This study found that the females differed from males on several personality scales. The result might suggest they could also differ in cognitive style. Thus females might respond to material more specifically suited to their style in a manner condusive to higher achievement and attitudes.

This study gives support to the concept of individualized instruction. It appears that materials differentiated according to general intelligence, personality and attitude might produce results in the individualized setting which more closely approach the optimum.

It might also be of value to repeat this study using different socio-economic levels and large random samples to extend the degree of generalization.

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APPENDIX A

TABLES FOR PART A

For Tables III to VII the scales used were numbered for convenience as follows:

(1) Attitude to Mathematics scale

(2) Achievement (Knowledge, Comprehension and Application Taxonomic level)

(3) Achievement (Analysis and Synthesis Taxonomic level)

(4) Total Achievement (Combined score of two and three)

(5) I.Q. scale

(6) Do scale (Dominance)

(7) Sy scale (Sociability)

(8) Sc scale (Self-Control)

(9) Cm scale (Communality)

(10) Fx scale (Flexibility)

(11) Fe scale (Femininity)

TABLE III

PEARSON PRODUCT-MOMENT CORRELATIONS USING THE ENTIRE SAMPLE

	1	2	3	4	5	6	7	8	9	10	11
1	1.00										
2	.26*	1.00									
3	.26*	.46*	1.00								
4	.30*	.94*	.71*	1.00							
5	.08	.48*	.41*	.53*	1.00						
6	.13	.24*	.18*	.26*	.27*	1.00					
7	.13	.18*	.27*	.24*	.19*	.57*	1.00				
8	.26*	.11	.08	.12	-.06	.18*	-.21*	1.00			
9	.25*	.38*	.15	.35*	.31*	.32*	.20*	-.03	1.00		
10	-.12	.13	.09	.13	.17*	-.06	-.02	-.04	.08	1.00	
11	.10	.15	.03	.13	.16	-.01	-.10	.23*	.26*	.10	1.00

* ($p < .05$)

TABLE IV

PEARSON PRODUCT-MOMENT CORRELATIONS USING THE I.Q. RANGE 84-94
(N=8)

	1	2	3	4	5	6	7	8	9	10	11
1	1.00										
2	-.23	1.00									
3	.02	-.17	1.00								
4	-.20	.71*	.36	1.00							
5	-.18	-.15	-.39	-.38	1.00						
6	.32	.02	-.16	-.07	.09	1.00					
7	.36	-.07	.64	.31	-.29	.40	1.00				
8	.05	.01	-.39	-.22	.41	.20	-.08	1.00			
9	.25	.48	-.50	.14	.33	.42	-.07	.22	1.00		
10	-.39	.16	-.55	-.17	.51	-.20	-.63	.07	.33	1.00	
11	.05	.10	-.59	-.26	.65	.23	-.24	.64	.58	.53	1.00

* ($p < .05$)

TABLE V

PEARSON PRODUCT-MOMENT CORRELATIONS USING THE I.Q. RANGE 95-109

(N=51)

	1	2	3	4	5	6	7	8	9	10	11
1	1.00										
2	.41*	1.00									
3	.21	.34*	1.00								
4	.41*	.92*	.63*	1.00							
5	-.03	.21	.32*	.29*	1.00						
6	.06	.18	.06	.17	.12	1.00					
7	-.18	.08	.13	.11	.07	.50*	1.00				
8	.38*	.17	.12	.18	-.13	-.17	-.22	1.00			
9	.23	.11	-.14	.04	-.06	.22	-.06	-.20	1.00		
10	-.07	.09	.25	.16	.09	-.05	.03	-.10	.09	1.00	
11	.21	.00	.12	.04	.12	-.08	-.02	.12	.19	-.06	1.00

* ($p < .05$)

TABLE VI

PEARSON PRODUCT-MOMENT CORRELATIONS USING THE I.Q. RANGE 110-120
(N=45)

	1	2	3	4	5	6	7	8	9	10	11
1	1.00										
2	.12	1.00									
3	.11	.47*	1.00								
4	.12	.92*	.72*	1.00							
5	-.15	.42*	.17	.39*	1.00						
6	.23	.04	.09	.08	.02	1.00					
7	.31*	.02	.19	.08	-.23	.59*	1.00				
8	.04	.23	-.05	.16	.06	-.26	-.24	1.00			
9	.31*	.47*	.30*	.47*	.01	.17	.30*	.06	1.00		
10	-.36*	.22	.25	.24	.16	.07	-.04	-.03	-.06	1.00	
11	.00	.19	.01	.15	.31*	-.09	-.20	.32*	.21	.86	1.00

* $(p < .05)$

TABLE VII

PEARSON PRODUCT-MOMENT CORRELATIONS USING THE I.Q. RANGE 121-136

	1	2	3	4	5	6	7	8	9	10	11
1	1.00										
2	.21	1.00									
3	.43*	.35*	1.00								
4	.33*	.91*	.65*	1.00							
5	-.08	.27	.00	.21	1.00						
6	.01	.34*	.22	.35*	.43*	1.00					
7	.14	.24	.19	.27	.16	.57*	1.00				
8	.42*	.08	.36*	.21	.00	-.11	-.15	1.00			
9	.07	.25	.10	.24	.09	.43*	.29	.13	1.00		
10	.02	-.02	-.21	.10	.22	-.10	-.02	-.01	-.02	1.00	
11	.01	.16	-.05	.11	.16	.08	-.15	.25	.27	.21	1.00

* ($p < .05$)

TABLES FOR PART B

TABLE VIII

THREE-WAY ANALYSIS OF VARIANCE ON THE SELF-CONTROL SCALE

Source	SS	DF	MS	F	p	$p < .05$
A	35.73	2	17.86	.34	.70	N.S.
B	472.87	2	236.43	4.55	.01	*
AB	236.98	4	59.24	1.14	.34	N.S.
C	30.50	1	30.50	.58	.44	N.S.
AC	112.87	2	56.43	1.08	.34	N.S.
BC	18.20	2	9.10	.17	.83	N.S.
ABC	207.84	4	51.96	1.00	.41	N.S.
ERROR	5602.27	108	51.87			

TABLE IX

COMPARISONS BETWEEN ORDERED PAIRS OF MEANS ON THE SELF-CONTROL SCALE SCORES (NEWMAN-KEULS METHOD)

SELF-CONTROL	Attitude:	L	M	H
		17.14	19.90	21.98
	17.14	-	2.76	4.84*
	19.90		-	2.08
	21.98			-

Steps	2	3
q.95 (r,108)	2.81	3.37

* ($p < .05$)

TABLE X

THREE-WAY ANALYSIS OF VARIANCE ON THE DOMINANCE SCALE

Source	SS	DF	MS	F	p	$p < .05$
A	465.34	2	232.67	5.95	.00	*
B	320.01	2	160.00	4.09	.01	*
AB	146.46	4	36.61	.93	.44	N.S.
C	18.28	1	18.28	.46	.49	N.S.
AC	138.90	2	69.45	1.77	.17	N.S.
BC	37.76	2	18.88	.48	.61	N.S.
ABC	186.90	4	46.72	1.19	.31	N.S.
ERROR	4222.85	108	39.10			

TABLE XI

COMPARISONS BETWEEN ORDERED PAIRS OF MEANS ON THE DOMINANCE SCALE SCORES (NEWMAN-KEULS METHOD)

DOMINANCE	Achievement:	L	M	H
		18.62	21.90	23.12
	18.62	-	2.28	4.50*
	21.90		-	1.22
	23.12			-

TABLE XII

COMPARISONS BETWEEN ORDERED PAIRS OF MEANS ON THE DOMINANCE SCALE SCORES (NEWMAN-KEULS METHOD)

DOMINANCE	Achievement:	L	M	H
		19.64	20.79	23.21
	19.64	-	1.15	3.57*
	20.79		-	2.43
	23.21			-

Steps	2	3
$q_{.95}$ (r,108)	2.81	3.37

* $(p < .05)$

TABLE XIII

THREE-WAY ANALYSIS OF VARIANCE ON THE SOCIABILITY SCALE

Source	SS	DF	MS	F	p	$p < .05$
A	107.34	2	53.67	2.09	.12	N.S.
B	189.06	2	94.53	3.69	.02	*
AB	89.65	4	22.41	.87	.48	N.S.
C	3.84	1	3.84	.14	.69	N.S.
AC	49.73	2	24.86	.97	.38	N.S.
BC	32.58	2	16.29	.63	.53	N.S.
ABC	32.12	4	8.03	.31	.86	N.S.
ERROR	2766.28	108	25.61			

TABLE XIV

COMPARISONS OF MEANS FOR THE SOCIABILITY SCALE SCORES (STUDENT'S-T TEST)

SOCIABILITY	Attitude:	M	L	H
		20.6	21.3	23.5
	20.6	-	1-N.S.	2-*
	21.3		-	3-*
	23.5			-

where: 1. $t = .63$
2. $t = 2.64$
3. $t = 2.00$

$t_{.05,108} = 1.66$ One-tailed test

*$(p < .05)$

TABLE XV

THREE-WAY ANALYSIS OF VARIANCE ON THE COMMUNALITY SCALE

Source	SS	DF	MS	F	p	p < .05
A	257.25	2	128.62	7.53	.00	*
B	44.44	2	22.22	1.30	.27	N.S.
AB	9.93	4	2.48	.14	.94	N.S.
C	112.38	1	112.38	6.58	.01	*
AC	2.87	2	1.43	.08	.91	N.S.
BC	40.06	2	20.03	1.17	.31	N.S.
ABC	53.46	4	13.36	.78	.53	N.S.
ERROR	1842.57	108	17.06			

TABLE XVI

COMPARISON BETWEEN ORDERED PAIRS OF MEANS ON THE COMMUNALITY SCALE SCORES (NEWMAN-KEULS METHOD)

COMMUNALITY	Attitude:	L	M	H
		20.52	21.64	23.91
	20.52	-	1.64	3.39*
	21.64		-	2.27
	23.91			-

Steps	2	3
q.95 (r,108)	2.81	3.37

* (p < .05)

TABLE XVII

THREE-WAY ANALYSIS OF VARIANCE ON THE FLEXIBILITY SCALE

Source	SS	DF	MS	F	p	$p < .05$
A	66.33	2	33.16	3.12	.04	*
B	24.57	2	12.28	1.15	.31	N.S.
AB	50.66	4	12.66	1.19	.31	N.S.
C	11.46	1	11.46	1.08	.30	N.S.
AC	107.15	2	53.57	5.05	.00	*
BC	81.96	2	40.98	3.86	.02	*
ABC	42.41	4	10.60	1.00	.41	N.S.
ERROR	1145.14	108	10.60			

TABLE XVIII

ANALYSIS OF VARIANCE FOR SIMPLE EFFECTS ON THE FLEXIBILITY SCALE

Source	SS	DF	MS	F	$p < .05$
C (sex), A-Achievement (L,M,H)					
C for A-L	48.22	1	48.22	4.55	*
C for A-M	58.15	1	58.15	5.48	*
C for A-H	21.43	1	21.43	2.02	N.S.
Within	1145.14	108	10.60		

F.05 (1,108) = 3.93

TABLE XIX

ANALYSIS OF VARIANCE FOR SIMPLE EFFECTS ON THE FLEXIBILITY SCALE

Source	SS	DF	MS	F	$p < .05$
C (sex), B (Attitude) (L,M,H)					
C for level B-L	4.02	1	4.02	.38	N.S.
C for level B-M	30.86	1	30.86	2.90	N.S.
C for level B-H	59.52	1	59.52	5.62	*
Within	1145.14	108	10.60		

F .05 (1,108) = 3.93

TABLE XX

THREE-WAY ANALYSIS OF VARIANCE ON THE FEMININITY SCALE

Source	SS	DF	MS	F	p	$p < .05$
A	12.44	2	6.22	.47	.62	N.S.
B	11.63	2	5.81	.44	.64	N.S.
AB	26.36	4	6.59	.49	.73	N.S.
C	1716.07	1	1716.07	130.04	.00	*
AC	3.04	2	1.52	.11	.89	N.S.
BC	35.28	2	17.64	1.33	.26	N.S.
ABC	19.38	4	4.84	.36	.83	N.S.
ERROR	1425.14	108	10.60			

TABLES FOR PART C

TABLE XXI

THREE-WAY ANALYSIS OF VARIANCE ON THE SELF-CONTROL SCALE

Source	SS	DF	MS	F	p	$p < .05$
A	62.35	2	31.17	.60	.55	N.S.
B	393.01	2	196.50	3.78	.02	*
AB	246.31	4	61.57	1.18	.32	N.S.
C	5.33	1	5.33	.10	.74	N.S.
AC	126.05	2	63.02	1.21	.30	N.S.
BC	13.72	2	6.86	.13	.87	N.S.
ABC	120.38	4	30.09	.57	.67	N.S.
ERROR	4672.99	90	51.92			

TABLE XXII

COMPARISONS BETWEEN ORDERED PAIRS OF MEANS ON THE SELF-CONTROL SCALE SCORES (NEWMAN-KEULS METHOD)

SELF-CONTROL	Attitude:	L	M	H
		15.88	19.19	21.08
	15.88	-	3.31*	5.20*
	19.19		-	1.89
	21.08			-

Steps	2	3
q.95 (r,90)	2.82	3.38

* ($p < .05$)

TABLE XXIII

THREE-WAY ANALYSIS OF VARIANCE ON THE DOMINANCE SCALE

Source	SS	DF	MS	F	p	p < .05
A	262.88	2	131.44	3.29	.04	*
B	103.38	2	51.69	1.29	.27	N.S.
AB	305.22	4	76.30	1.91	.11	N.S.
C	22.23	1	22.23	.55	.45	N.S.
AC	166.74	2	83.37	2.09	.12	N.S.
BC	20.68	2	10.34	.25	.77	N.S.
ABC	221.59	4	55.39	1.38	.24	N.S.
ERROR	3589.49	90	39.88			

TABLE XXIV

COMPARISONS BETWEEN ORDERED PAIRS OF MEANS ON THE DOMINANCE SCALE SCORES (NEWMAN-KEULS METHOD)

DOMINANCE	Achievement:	L	M	H
		18.97	21.55	23.25
	18.97	-	2.58	4.28*
	21.55		-	1.70
	23.25			-

Steps	2	3
q.95 (r,90)	2.82	3.38

* $(p < .05)$

TABLE XXV

THREE-WAY ANALYSIS OF VARIANCE ON THE SOCIABILITY SCALE

Source	SS	DF	MS	F	p	$p < .05$
A	38.88	2	19.44	.72	.48	N.S.
B	67.16	2	33.58	1.25	.29	N.S.
AB	66.61	4	16.65	.62	.64	N.S.
C	11.34	1	11.34	.42	.51	N.S.
AC	28.74	2	14.37	.53	.58	N.S.
BC	7.46	2	3.73	.13	.87	N.S.
ABC	61.20	4	15.30	.57	.68	N.S.
ERROR	2409.49	90	26.77			

TABLE XXVI

THREE-WAY ANALYSIS OF VARIANCE ON THE COMMUNALITY SCALE

Source	SS	DF	MS	F	p	$p < .05$
A	320.05	2	160.02	10.87	.00	*
B	62.72	2	31.36	2.13	.12	N.S.
AB	32.88	4	8.22	.55	.69	N.S.
C	65.33	1	65.33	4.43	.03	*
AC	3.38	2	1.69	.11	.89	N.S.
BC	105.05	2	52.52	3.56	.03	*
ABC	101.55	4	25.38	1.72	.15	N.S.
ERROR	1324.66	90	14.71			

TABLE XXVII

COMPARISONS BETWEEN ORDERED PAIRS OF MEANS ON THE COMMUNALITY SCALE SCORES (NEWMAN-KEULS METHOD)

COMMUNALITY	Achievement:	L	M	H
		20.30	21.94	24.72
	20.30	-	1.64	4.42*
	21.94		-	2.78
	24.72			-

Steps	2	3
q.95 (r,90)	2.82	3.38

* $(p < .05)$

TABLE XXVIII

ANALYSIS OF VARIANCE FOR SIMPLE EFFECTS ON THE COMMUNALITY SCALE

Source	SS	DF	MS	F	p<.05
C (sex), B (Attitude levels L,M.H)					
C for level B-1	122.24	1	122.24	8.27	*
C for level B-M	4.00	1	4.00	.28	N.S.
C for level B-H	1.00	1	1.00	.07	N.S.
Within	1324.66	90	14.71		

F .05 (1,90) = 3.96

TABLE XXIX

THREE-WAY ANALYSIS OF VARIANCE ON THE FLEXIBILITY SCALE

Source	SS	DF	MS	F	p	$p < .05$
A	72.29	2	36.14	3.32	.04	*
B	87.62	2	43.81	4.02	.02	*
AB	32.31	4	8.07	.74	.56	N.S.
C	35.59	1	35.59	3.27	.07	N.S.
AC	134.29	2	67.14	6.17	.00	*
BC	43.62	2	21.81	2.00	.14	N.S.
ABC	1.31	4	.32	.03	.99	N.S.
ERROR	978.99	90	10.87			

TABLE XXX

THE ANALYSIS OF VARIANCE FOR SIMPLE EFFECTS ON THE FLEXIBILITY SCALE

Source	SS	DF	MS	F	$p < .05$
C (sex), A (achievement, L,M,H)					
C for level A-L	47.38	1	47.38	4.39	*
C for level A-M	75.11	1	75.11	6.95	*
C for level A-H	36.00	1	36.00	3.33	N.S.
Within	978.99	90	10.87		

$F_{.05}(1,90) = 3.96$

TABLE XXXI

COMPARISONS BETWEEN MEANS ON THE FLEXIBILITY SCALE SCORES (STUDENT'S-T TEST METHOD)

FLEXIBILITY	Attitude:	L	M	H
		7.05	8.77	9.36
	7.05	-	1-*	2-*
	8.77		-	3-N.S.
	9.36			-

where: 1. $t = 2.39$
2. $t = 3.04$
3. $t = .77$

$t_{.05,90} = 1.66$ One-tailed test

* $(p < .05)$

TABLE XXXII

THREE-WAY ANALYSIS OF VARIANCE ON THE FEMININITY SCALE

Source	SS	DF	MS	F	p	$p < .05$
A	28.35	2	14.17	1.22	.29	N.S.
B	8.57	2	4.28	.37	.69	N.S.
AB	22.48	4	5.62	.48	.74	N.S.
C	1288.23	1	1288.23	111.42	.00	*
AC	15.12	2	7.56	.65	.52	N.S.
BC	11.79	2	5.89	.51	.60	N.S.
ABC	10.59	4	2.64	.22	.92	N.S.
ERROR	1040.49	90	11.56			

TABLES FOR PART D

TABLE XXXIII

THREE-WAY ANALYSIS OF VARIANCE ON THE SELF-CONTROL SCALE

Source	SS	DF	MS	F	p	$p < .05$
A	23.57	2	11.78	.28	.75	N.S.
B	444.74	2	222.37	5.38	.00	*
AB	91.81	4	22.95	.55	.69	N.S.
C	3.00	1	3.00	.07	.78	N.S.
AC	108.38	2	54.19	1.31	.27	N.S.
BC	2.88	2	1.44	.03	.96	N.S.
ABC	180.55	4	45.13	1.09	.36	N.S.
ERROR	3714.33	90	41.12			

TABLE XXXIV

COMPARISONS BETWEEN ORDERED PAIRS OF MEANS ON THE SELF-CONTROL SCALE SCORES (NEWMAN-KEULS METHOD)

SELF-CONTROL	Attitude:	L	M	H
		15.47	19.72	20.66
	15.47	-	3.25*	5.19*
	19.72		-	.94
	20.66			-

Steps	2	3
q.95 (r,90)	2.81	3.38

* $(p < .05)$

TABLE XXXV

THREE-WAY ANALYSIS OF VARIANCE ON THE DOMINANCE SCALE

Source	SS	DF	MS	F	p	$p < .05$
A	62.35	2	31.17	.80	.45	N.S.
B	172.46	2	86.23	2.21	.11	N.S.
AB	78.42	4	19.60	.50	.73	N.S.
C	4.08	1	4.08	.10	.74	N.S.
AC	77.72	2	38.86	1.00	.37	N.S.
BC	113.38	2	56.69	1.45	.23	N.S.
ABC	142.05	4	35.51	.91	.45	N.S.
ERROR	3496.49	90	38.84			

TABLE XXXVI

THREE-WAY ANALYSIS OF VARIANCE ON THE SOCIABILITY SCALE

Source	SS	DF	MS	F	p	$p < .05$
A	113.68	2	56.84	2.46	.09	N.S.
B	332.74	2	166.37	7.20	.00	*
AB	72.20	4	18.05	.78	.53	N.S.
C	.23	1	.23	.01	.92	N.S.
AC	13.35	2	6.67	.28	.74	N.S.
BC	47.18	2	23.59	1.02	.36	N.S.
ABC	46.98	4	11.74	.50	.72	N.S.
ERROR	2076.83	90	23.07			

TABLE XXXVII

COMPARISONS BETWEEN ORDERED PAIRS OF MEANS ON THE SOCIABILITY SCALE SCORES (NEWMAN-KEULS METHOD)

SOCIABILITY	Attitude:	L	M	H
		20.99	21.08	24.75
	20.99	-	.09	3.76*
	21.08		-	3.67*
	24.75			-

Steps	2	3
q.95	2.81	3.38

* $(p < .05)$

TABLE XXXVIII

THREE-WAY ANALYSIS OF VARIANCE ON THE COMMUNALITY SCALE

Source	SS	DF	MS	F	p	$p < .05$
A	40.79	2	20.39	1.32	.27	N.S.
B	75.12	2	37.56	2.43	.09	N.S.
AB	7159.25	4	17.89	1.16	.33	N.S.
C	151.70	1	151.70	9.85	.00	*
AC	10.90	2	5.45	.35	.70	N.S.
BC	29.24	2	14.62	.94	.39	N.S.
ABC	139.81	4	34.95	2.26	.06	N.S.
ERROR	1385.99	90	15.39			

TABLE XXXIX

THREE-WAY ANALYSIS OF VARIANCE ON THE FLEXIBILITY SCALE

Source	SS	DF	MS	F	p	$p < .05$
A	63.16	2	31.58	2.46	.09	N.S.
B	25.38	2	12.69	.99	.37	N.S.
AB	63.11	4	15.77	1.23	.30	N.S.
C	18.75	1	18.75	1.46	.22	N.S.
AC	5.72	2	2.86	.22	.80	N.S.
BC	66.16	2	33.08	2.58	.08	N.S.
ABC	41.44	4	10.36	.80	.52	N.S.
ERROR	1152.49	90	12.80			

TABLE XL

THREE-WAY ANALYSIS OF VARIANCE ON THE FEMININITY SCALE

Source	SS	DF	MS	F	p	$p < .05$
A	17.05	2	8.52	.87	.41	N.S.
B	43.16	2	21.58	2.22	.11	N.S.
AB	8.94	4	2.23	.23	.92	N.S.
C	1166.68	1	1166.87	120.27	.00	*
AC	6.68	2	3.34	.34	.70	N.S.
BC	16.78	2	8.39	.86	.42	N.S.
ABC	34.20	4	8.55	.88	.47	N.S.
ERROR	873.16	90	9.70			

TABLES FOR PART E

TABLE XLI

THREE-WAY ANALYSIS OF VARIANCE ON THE SELF-CONTROL SCALE

Source	SS	DF	MS	F	p	$p < .05$
A	17.14	2	8.57	.20	.81	N.S.
B	18.37	2	9.18	.22	.80	N.S.
AB	212.74	4	53.18	1.28	.29	N.S.
C	400.16	1	400.16	9.67	.00	*
AC	92.33	2	46.16	1.11	.33	N.S.
BC	33.33	2	16.66	.40	.67	N.S.
ABC	133.33	4	33.33	.80	.52	N.S.
ERROR	1488.66	36	41.35			

TABLE XLII

THREE-WAY ANALYSIS OF VARIANCE ON THE DOMINANCE SCALE

Source	SS	DF	MS	F	p	$p < .05$
A	159.59	2	79.79	2.20	.12	N.S.
B	178.48	2	89.24	2.46	.09	N.S.
AB	243.07	4	60.76	1.68	.17	N.S.
C	.16	1	.16	.00	.94	N.S.
AC	178.77	2	89.38	2.47	.09	N.S.
BC	78.11	2	39.05	1.08	.35	N.S.
ABC	32.11	4	8.02	.22	.92	N.S.
ERROR	1301.33	36	36.14			

TABLE XLIII

THREE-WAY ANALYSIS OF VARIANCE ON THE SOCIABILITY SCALE

Source	SS	DF	MS	F	p	$p < .05$
A	30.77	2	15.38	.54	.58	N.S.
B	221.44	2	110.72	3.93	.02	*
AB	124.44	4	31.11	1.10	.36	N.S.
C	39.18	1	39.18	1.39	.24	N.S.
AC	15.81	2	7.90	.28	.75	N.S.
BC	.48	2	.24	.00	.99	N.S.
ABC	83.85	4	20.96	.74	.56	N.S.
ERROR	1013.33	36	28.14			

TABLE XLIV

COMPARISONS BETWEEN ORDERED PAIRS OF MEANS ON THE SOCIABILITY SCALE SCORES (NEWMAN-KEULS METHOD)

SOCIABILITY	Attitudes:	M	L	H
		31.58	32.92	40.33
	31.58	-	1.34	8.75*
	32.92		-	7.41*
	40.33			-

Steps	2	3
q.95 (r,36)	2.87	3.46

* ($p < .05$)

TABLE XLV

THREE-WAY ANALYSIS OF VARIANCE ON THE COMMUNALITY SCALE

Source	SS	DF	MS	F	p	$p < .05$
A	64.59	2	32.29	2.65	.08	N.S.
B	153.81	2	76.90	6.31	.00	*
AB	32.40	4	8.10	.66	.62	N.S.
C	93.35	1	93.35	7.66	.00	*
AC	53.92	2	26.96	2.21	.12	N.S.
BC	49.59	2	24.79	2.03	.14	N.S.
ABC	23.96	4	5.99	.49	.74	N.S.
ERROR	438.66	36	12.18			

TABLE XLVI

COMPARISONS BETWEEN ORDERED PAIRS OF MEANS ON THE COMMUNALITY SCALE SCORES (NEWMAN-KEULS METHOD)

COMMUNALITY	Attitude:	L	M	H
		20.55	21.44	24.22
	20.55	-	.89	3.67*
	21.44		-	2.78*
	24.22			-

Steps	2	3
q.95 (r, 36)	2.87	3.46

* $(p < .05)$

TABLE XLVII

THREE-WAY ANALYSIS OF VARIANCE ON THE FLEXIBILITY SCALE

Source	SS	DF	MS	F	p	$p < .05$
A	56.33	2	28.16	2.56	.09	N.S.
B	75.44	2	37.72	3.44	.04	*
AB	37.22	4	93.05	.84	.50	N.S.
C	2.66	1	2.66	.24	.64	N.S.
AC	.77	2	.38	.03	.96	N.S.
BC	14.11	2	7.05	.64	.53	N.S.
ABC	34.77	4	8.69	.79	.53	N.S.
ERROR	394.66	36	10.96			

TABLE XLVIII

COMPARISONS BETWEEN ORDERED PAIRS OF MEANS ON THE FLEXIBILITY SCALE SCORES (NEWMAN-KEULS METHOD)

FLEXIBILITY	Attitude:	H	M	L
		7.50	9.11	10.38
	7.50	-	1.61	2.88*
	9.11		-	1.27
	10.38			-

Steps	2	3
q.95 (r,36)	2.87	3.46

* $(p < .05)$

TABLE XLIX

THREE-WAY ANALYSIS OF VARIANCE ON THE FEMININITY SCALE

Source	SS	DF	MS	F	p	$p < .05$
A	1.00	2	.50	.04	.95	N.S.
B	27.44	2	13.72	1.35	.26	N.S.
AB	58.22	4	14.55	1.44	.24	N.S.
C	620.16	1	620.16	61.44	.00	*
AC	19.00	2	9.50	.94	.39	N.S.
BC	43.00	2	21.50	2.13	.13	N.S.
ABC	2.66	4	.66	.06	.99	N.S.
ERROR	363.33	36	10.09			

TABLE L

THREE-WAY ANALYSIS OF VARIANCE ON THE SELF-CONTROL SCALE

Source	SS	DF	MS	F	p	$p < .05$
A	200.77	2	100.38	2.26	.11	N.S.
B	324.11	2	162.05	3.66	.03	*
AB	167.77	4	41.94	.94	.44	N.S.
C	342.51	1	342.51	7.74	.00	*
AC	97.81	2	48.90	1.10	.34	N.S.
BC	79.14	2	39.57	.89	.41	N.S.
ABC	64.51	4	16.12	.36	.83	N.S.
ERROR	1592.66	36	44.24			

TABLE LI

COMPARISONS BETWEEN ORDERED PAIRS OF MEANS ON THE SELF-CONTROL SCALE SCORES (NEWMAN-KEULS METHOD)

SELF-CONTROL	Attitude:	L	H	M
		15.17	19.12	21.06
	15.17	-	3.95*	5.89*
	19.12		-	1.94
	21.06			-

Steps	2	3
q.95 (r,36)	2.87	3.46

* $(p < .05)$

TABLE LII

THREE-WAY ANALYSIS OF VARIANCE ON THE DOMINANCE SCALE

Source	SS	DF	MS	F	p	$p < .05$
A	49.37	2	24.68	.13	.87	N.S.
B	363.37	2	131.68	.70	.49	N.S.
AB	107.96	4	26.99	.14	.96	N.S.
C	510.29	1	510.29	2.74	.10	N.S.
AC	26.70	2	13.35	.07	.93	N.S.
BC	66.03	2	33.01	.17	.83	N.S.
ABC	77.29	4	19.32	.10	.98	N.S.
ERROR	6691.98	36	185.88			

TABLE LIII

THREE-WAY ANALYSIS OF VARIANCE ON THE SOCIABILITY SCALE

Source	SS	DF	MS	F	p	$p < .05$
A	30.77	2	15.38	.54	.58	N.S.
B	221.44	2	110.72	3.93	.02	*
AB	124.44	4	31.11	1.10	.36	N.S.
C	39.18	1	39.18	1.10	.24	N.S.
AC	15.81	2	7.90	1.39	.75	N.S.
BC	.48	2	.24	.28	.99	N.S.
ABC	83.85	4	20.96	.00	.56	N.S.
ERROR	1013.33	36	28.14	.74		

TABLE LIV

COMPARISONS BETWEEN ORDERED PAIRS OF MEANS ON THE SOCIABILITY SCALE SCORES (NEWMAN-KEULS METHOD)

SOCIABILITY	Attitude:	L	H	M
		15.17	19.21	21.06
	15.17	-	4.04*	5.89*
	19.21		-	1.85
	21.06			-

Steps	2	3
q.95	2.87	3.46

* $(p < .05)$

TABLE LV

THREE-WAY ANALYSIS OF VARIANCE ON THE COMMUNALITY SCALE

Source	SS	DF	MS	F	p	$p < .05$
A	7.81	2	3.90	.40	.66	N.S.
B	151.81	2	75.90	7.95	.00	*
AB	18.96	4	4.74	.49	.73	N.S.
C	115.57	1	115.57	12.11	.00	*
AC	36.03	2	18.01	1.88	.16	N.S.
BC	49.37	2	24.68	2.58	.08	N.S.
ABC	19.85	4	4.96	.52	.72	N.S.
ERROR	343.33		9.53			

TABLE LVI

COMPARISONS BETWEEN ORDERED PAIRS OF MEANS ON THE COMMUNALITY SCALE SCORES (NEWMAN-KEULS METHOD)

COMMUNALITY	Attitude:	L	M	H
		21.00	21.66	25.17
	21.00	-	.66	4.17*
	21.66		-	3.51*
	25.17			-

Steps	2	3
q.95 (r,36)	2.87	3.46

* $(p < .05)$

TABLE LVII

THREE-WAY ANALYSIS OF VARIANCE ON THE FLEXIBILITY SCALE

Source	SS	DF	MS	F	p	$p < .05$
A	24.77	2	12.38	1.19	.31	N.S.
B	44.11	2	22.05	2.11	.13	N.S.
AB	13.77	4	3.44	.33	.85	N.S.
C	2.24	1	2.24	.21	.64	N.S.
AC	9.59	2	4.79	.46	.63	N.S.
BC	7.81	2	3.90	.37	.68	N.S.
ABC	41.85	4	10.46	1.00	.41	N.S.
ERROR	374.66	36	10.40			

TABLE LVIII

THREE-WAY ANALYSIS OF VARIANCE ON THE FEMININITY SCALE

Source	SS	DF	MS	F	p	$p < .05$
A	17.92	2	8.96	.42	.65	N.S.
B	51.14	2	25.57	1.20	.31	N.S.
AB	19.85	4	4.96	.23	.91	N.S.
C	101.40	1	101.40	4.79	.03	*
AC	17.92	2	8.96	.42	.65	N.S.
BC	51.14	2	25.57	1.20	.31	N.S.
ABC	19.85	4	4.96	.23	.91	N.S.
ERROR	761.33	36	21.14			

TABLE LIX

THREE-WAY ANALYSIS OF VARIANCE ON THE SELF-CONTROL SCALE

Source	SS	DF	MS	F	p	$p < .05$
A	228.16	2	114.08	2.13	.14	N.S.
B	55.16	2	27.58	.51	.60	N.S.
AB	276.66	4	69.16	1.29	.31	N.S.
C	49.00	1	49.00	.91	.35	N.S.
AC	24.50	2	12.25	.22	.79	N.S.
BC	50.16	2	25.08	.46	.63	N.S.
ABC	44.33	4	11.08	.20	.93	N.S.
ERROR	963.99	18	53.55			

TABLE LX

THREE-WAY ANALYSIS OF VARIANCE ON THE DOMINANCE SCALE

Source	SS	DF	MS	F	p	$p < .05$
A	120.16	2	60.08	2.02	.16	N.S.
B	186.00	2	93.00	3.13	.06	N.S.
AB	92.33	4	23.08	.77	.55	N.S.
C	61.69	1	.69	.02	.88	N.S.
AC	20.05	2	10.02	.33	.71	N.S.
BC	20.22	2	10.11	.34	.71	N.S.
ABC	193.77	4	48.44	1.63	.20	N.S.
ERROR	533.49	18	29.63			

TABLE LXI

THREE-WAY ANALYSIS OF VARIANCE ON THE SOCIABILITY SCALE

Source	SS	DF	MS	F	p	$p < .05$
A	88.66	2	44.33	2.56	.10	N.S.
B	44.66	2	22.33	1.29	.29	N.S.
AB	111.16	4	27.79	1.60	.21	N.S.
C	61.36	1	61.36	3.54	.07	N.S.
AC	38.22	2	19.11	1.10	.35	N.S.
BC	84.22	2	42.11	2.43	.11	N.S.
ABC	12.94	4	3.23	.18	.94	N.S.
ERROR	311.49	18	17.30			

TABLE LXII

THREE-WAY ANALYSIS OF VARIANCE ON THE COMMUNALITY SCALE

Source	SS	DF	MS	F	p	$p < .05$
A	7.38	2	3.69	.18	.82	N.S.
B	1.05	2	.52	.02	.93	N.S.
AB	219.44	4	54.86	2.80	.05	N.S.
C	66.69	1	66.69	3.41	.08	N.S.
AC	15.72	2	7.86	.40	.67	N.S.
BC	75.05	2	37.52	1.92	.17	N.S.
ABC	190.77	4	47.69	2.44	.08	N.S.
ERROR	351.49	18	19.52			

TABLE LXIII

THREE-WAY ANALYSIS OF VARIANCE ON THE FLEXIBILITY SCALE

Source	SS	DF	MS	F	p	$p < .05$
A	21.55	2	10.77	.89	.42	N.S.
B	1.72	2	.86	.07	.93	N.S.
AB	50.11	4	12.52	1.03	.41	N.S.
C	1.36	1	1.36	.11	.74	N.S.
AC	150.88	2	75.44	6.24	.00	*
BC	2.72	2	1.36	.11	.89	N.S.
ABC	87.77	4	21.94	1.81	.16	N.S.
ERROR	217.49	18	12.08			

TABLE LXIV

ANALYSIS OF VARIANCE FOR SIMPLE EFFECTS ON FLEXIBILITY

Source	SS	DF	MS	F	$p < .05$
C (sex), A (achievement L,M,H)					
C for level A-L	210.00	1	210.00	17.38	*
C for level A-M	5.25	1	5.25	.43	N.S.
C for level A-H	110.25	1	110.25	9.21	*
Within	217.49	18	12.08		

$F_{.05}\ (1,18) = 4.41$

TABLE LXV

THREE-WAY ANALYSIS OF VARIANCE ON THE FEMININITY SCALE

Source	SS	DF	MS	F	p	$p < .05$
A	10.88	2	5.44	.08	.91	N.S.
B	2.88	2	1.44	.02	.97	N.S.
AB	63.27	4	15.81	.25	.90	N.S.
C	476.69	1	476.69	7.74	.01	*
AC	10.88	2	5.44	.08	.91	N.S.
BC	2.88	2	1.44	.02	.97	N.S.
ABC	63.27	4	15.81	.25	.90	N.S.
ERROR	1107.49	18	61.52			

TABLE LXVI

THREE-WAY ANALYSIS OF VARIANCE ON THE SELF-CONTROL SCALE

Source	SS	DF	MS	F	p	$p < .05$
A	27.72	2	13.86	.25	.77	N.S.
B	63.72	2	31.86	.59	.56	N.S.
AB	178.27	4	44.56	.83	.52	N.S.
C	191.36	1	191.36	3.56	.07	N.S.
AC	157.38	2	78.69	1.46	.25	N.S.
BC	253.72	2	126.86	2.36	.12	N.S.
ABC	78.27	4	19.56	.36	.83	N.S.
ERROR	966.49	18	53.69			

TABLE LXVII

THREE-WAY ANALYSIS OF VARIANCE ON THE DOMINANCE SCALE

Source	SS	DF	MS	F	p	$p < .05$
A	8.72	2	4.36	.11	.88	N.S.
B	107.72	2	53.86	1.46	.25	N.S.
AB	30.44	4	7.61	.20	.93	N.S.
C	.11	1	.11	.00	.95	N.S.
AC	.47	2	23.69	.64	.53	N.S.
BC	.35	2	17.69	.68	.62	N.S.
ABC	.27	4	67.52	1.83	.16	N.S.
ERROR	.66	18	36.77			

TABLE LXVIII

THREE-WAY ANALYSIS OF VARIANCE ON THE SOCIABILITY SCALE

Source	SS	DF	MS	F	p	$p < .05$
A	15.38	2	7.69	.37	.69	N.S.
B	58.72	2	29.36	1.42	.26	N.S.
AB	13.44	4	3.36	.16	.95	N.S.
C	1.00	1	1.00	.04	.82	N.S.
AC	68.16	2	34.08	1.65	.21	N.S.
BC	132.16	2	66.08	3.21	.06	N.S.
ABC	142.66	4	35.66	1.73	.18	N.S.
ERROR	369.99	18	20.55			

TABLE LXIX

THREE-WAY ANALYSIS OF VARIANCE ON THE COMMUNALITY SCALE

Source	SS	DF	MS	F	p	$p < .05$
A	24.66	2	12.33	.63	.54	N.S.
B	24.50	2	12.25	.62	.54	N.S.
AB	34.33	4	8.58	.43	.77	N.S.
C	124.69	1	124.69	6.38	.02	*
AC	26.88	2	13.44	.68	.51	N.S.
BC	89.38	2	44.69	2.28	.13	N.S.
ABC	68.77	4	17.19	.88	.49	N.S.
ERROR	351.49	18	19.52			

TABLE LXX

THREE-WAY ANALYSIS OF VARIANCE ON THE FLEXIBILITY SCALE

Source	SS	DF	MS	F	p	$p < .05$
A	62.16	2	31.08	1.77	.19	N.S.
B	10.50	2	5.25	.29	.74	N.S.
AB	22.33	4	5.58	.31	.86	N.S.
C	17.36	1	17.36	.99	.33	N.S.
AC	70.05	2	35.02	1.99	.16	N.S.
BC	.38	2	.19	.01	.98	N.S.
ABC	32.44	4	8.11	.46	.76	N.S.
ERROR	315.49	18	17.52			

TABLE LXXI

THREE-WAY ANALYSIS OF VARIANCE ON THE FEMININITY SCALE

Source	SS	DF	MS	F	p	$p < .05$
A	57.05	2	28.52	1.48	.25	N.S.
B	.72	2	.36	.01	.98	N.S.
AB	27.44	4	6.86	.35	.83	N.S.
C	225.00	1	225.00	11.70	.00	*
AC	36.50	2	18.25	.94	.40	N.S.
BC	8.16	2	4.08	.21	.81	N.S.
ABC	48.33	4	12.08	.62	.64	N.S.
ERROR	345.99	18	19.22			

TABLE LXXII

SCALES SIGNIFICANTLY RELATED TO ATTITUDE BY PARTS B, C AND D

	Sc	Do	Sy	Cm	Fx	Fe
Part B	*	*	*	X	X	X
Part C	*	X	*	X	*	X
Part D	*	X	X	X	X	X
General Agreement (2 out of 3)	*	X	*	X	X	X

* = significantly related to attitude

X = not significantly related to attitude

TABLES FOR PART F

TABLE LXXIII

STATISTICAL RESULTS FOR THE PREDICTION OF ACHIEVEMENT WITHIN A1 USING EIGHT PREDICTORS

Step	Variable Entering	Prob. Level	$p < .05$	Percentage Variance Accounted For
1	I.Q.	.00	*	23.7
2	Communality	.00	*	29.6
3	Attitude	.01	*	32.7
4	Self-Control	.13	N.S.	33.8
5	Dominance	.29	N.S.	34.3
6	Flexibility	.25	N.S.	34.9
7	Sociability	.68	N.S.	35.0
8	Femininity	.81	N.S.	35.0

THE BEST FITTING EQUATION FOR PREDICTING ACHIEVEMENT (KNOWLEDGE, COMPREHENSION AND APPLICATION TAXONOMIC LEVELS):

$$Y_{\text{achievement}} = .06\, X_{\text{I.Q.}} + .15\, X_{\text{Cm}} + .21\, X_{\text{Attitude}} - 8.54$$

TABLE LXXIV

STATISTICAL RESULTS FOR THE PREDICTION OF ACHIEVEMENT WITHIN A2 USING EIGHT PREDICTORS

Step	Variable Entering	Prob. Level	$p < .05$	Percentage Variance Accounted For
1	I.Q.	.00	*	17.1
2	Attitude	.00	*	22.6
3	Sociability	.01	*	25.5
4	Self-Control	.20	N.S.	26.3
5	Flexibility	.41	N.S.	26.7
6	Communality	.40	N.S.	27.0
7	Femininity	.55	N.S.	27.2
8	Dominance	.68	N.S.	27.3

THE BEST FITTING EQUATION FOR PREDICTING ACHIEVEMENT (ANALYSIS AND SYNTHESIS TAXONOMIC LEVEL):

$$Y_{\text{achievement}} = .03\ X_{\text{I.Q.}} + .06\ X_{\text{Attitude}} + .07\ X_{\text{Sy}} - 6.62$$

TABLE LXXV

STATISTICAL RESULTS FOR THE PREDICTION OF ACHIEVEMENT WITHIN A3 USING EIGHT PREDICTORS

Step	Variable Entering	Prob. Level	$p < .05$	Percentage Variance Accounted For
1	I.Q.	.00	*	28.0
2	Attitude	.00	*	34.9
3	Communality	.03	*	36.8
4	Self-Control	.15	N.S.	37.7
5	Sociability	.07	N.S.	39.1
6	Flexibility	.25	N.S.	39.6
7	Dominance	.59	N.S.	39.8
8	Femininity	.65	N.S.	39.8

THE BEST FITTING EQUATION FOR PREDICTING ACHIEVEMENT (ALL TAXONOMIC LEVELS COMBINED):

$$Y_{\text{achievement}} = .09\ X_{\text{I.Q.}} + .22\ X_{\text{Attitude}} + .19\ X_{\text{Cm}} - 14.37$$

TABLE LXXVI

STATISTICAL RESULTS FOR THE PREDICTION OF ATTITUDE USING TEN PREDICTORS

Step	Variable Entering	Prob. Level	$p < .05$	Percentage Variance Accounted For
1	Achievement A3	.00	*	9.1
2	Self-Control	.00	*	14.2
3	Communality	.03	*	17.0
4	Flexibility	.03	*	19.5
5	Achievement A2	.19	N.S.	20.5
6	I.Q.	.25	N.S.	21.2
7	Sociability	.29	N.S.	21.9
8	Achievement A1	.76	N.S.	21.9
9	Do	.75	N.S.	21.9
10	Fe	.95	N.S.	21.9

THE BEST FITTING PREDICTION EQUATION TO DETERMINE ATTITUDE TO MATHEMATICS:

$$Y_{Attitude} = .59\,X_{Achievement} + .45\,X_{Sc} + .60\,X_{Cm} - .65\,X_{Fx} + 42.00$$

TABLE LXXVII

TEST ITEMS RETAINED FOR THE KNOWLEDGE, APPLICATION, COMPREHENSION TAXONOMIC LEVEL

Pilot Item No.	Final No.	Difficulty	Biserial Corr.	Item Rel. Index
1	1	.71	.42	.19
2	2	.60	.61	.30
3	3	.64	.31	.15
4	4	.60	.47	.23
8	5	.56	.39	.19
10	6	.67	.35	.16
11	7	.79	.34	.14
12	8	.69	.52	.24
13	9	.77	.61	.25
14	10	.45	.45	.22
15	11	.52	.59	.29
17	12	.94	.62	.14
18	13	.77	.33	.14
20	14	.56	.60	.30
21	15	.49	.31	.11
22	16	.49	.28	.14
23	17	.45	.43	.21
25	18	.37	.47	.22
26	19	.64	.28	.13
28	20	.45	.40	.20
29	21	.94	.73	.16
30	22	.88	.60	.19
31	23	.71	.43	.19
32	24	.56	.42	.21
33	25	.84	.42	.15
34	26	.92	.51	.13
35	27	.81	.32	.12
36	28	.60	.36	.17
37	29	.51	.26	.13
38	30	.88	.39	.12
		ITEMS DISCARDED		
5		.60	.18	.09
6		.49	.04	.02
7		.50	.07	.03
9		.49	-.03	-.01
16		.28	.10	.04
19		.24	.12	.05
24		.88	.23	.07
27		.94	.13	.03
39		.86	.26	.09

KR-20 Reliability = 0.64
Test mean = 25.58
Test Var. = 19.98

TABLE LXXVIII

TEST ITEMS RETAINED FOR THE OPEN SEARCH TAXONOMIC LEVEL

Pilot Item No.	Final No.	Difficulty	Biserial Corr.	Item Rel. Index
1	1	.62	.69	.33
2	2	.43	.71	.35
3	3	.58	.59	.29
4	4	.72	.37	.16
5	5	.56	.59	.29
6	6	.66	.39	.18
9	7	.47	.28	.14
10	8	.51	.36	.18
11	9	.33	.30	.14
13	10	.64	.30	.14
		ITEMS DISCARDED		
7		.55	.23	.11
8		.66	.10	.04
12		.58	.23	.11

KR-20 Reliability = 0.23
Test mean = 7.39
Test Var. = 3.92

APPENDIX B

MATHEMATICS ACHIEVEMENT TEST -- PART A

MOST QUESTIONS ARE FROM GRADE SEVEN.

TIME: 1/2 hour

Attempt All Questions

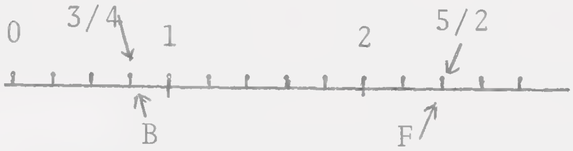
PART A

KNOWLEDGE, COMPREHENSION AND APPLICATION

MATHEMATICS ACHIEVEMENT TEST

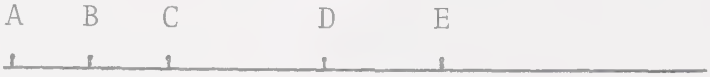
1. The measure of segment BF is how many units long?

   a) 2/4
   b) 3/4
   c) 1 1/2
   d) 1 3/4



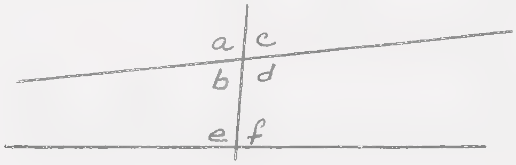
2. If $\overline{AB} \cong \overline{BC}$ and $\overline{AC} \cong \overline{CD}$ and $\overline{CD} \cong \overline{DE}$ which of the following is true?

   a) $\overline{AC} \cong \overline{DB}$
   b) $\overline{AB} \cong \overline{DC}$
   c) $\overline{DE} \cong \overline{BA}$
   d) $\overline{CE} \cong \overline{BD}$
   e) $\overline{CA} \cong \overline{DE}$



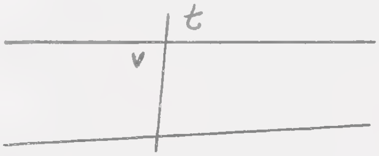
3. Angle 'c' and what other angle are corresponding angles of two coplanar lines and transversal?

   a) a
   b) b
   c) d
   d) e
   e) f



4. Angle 't' and angle 'v' are which type of angles?

   a) opposite angles
   b) linear pair of angles
   c) adjacent angles
   d) transversal angles
   e) diagonol angles



5. The set of all parallelograms is a subset of which set named below?

   a) the set of all rectangles
   b) the set of all quadrilaterals
   c) the set of all octagons
   d) the set of all squares
   e) the set of all hexagons

6. What is the union of any simple closed curve and its interior?

   a) a closed region
   b) an area
   c) a rectangular region
   d) a circle
   e) a sphere

7. The number associated with a point in a number line is the ___?___ of the point?

a) measure
b) numeral
c) supplement
d) coordinate
e) segment

8. An acute triangle has exactly how many acute angles?

a) 0
b) 1
c) 2
d) 3
e) 1 OR 2 OR 3

9. If $\angle a \cong \angle b$ then $\angle a$ __?__ $\angle b$.

a) $>$
b) $\ncong$
c) $<$
d) $=$
e) $\neq$

10. In a right triangle, the sum of the measures of the two acute angles in degrees is?

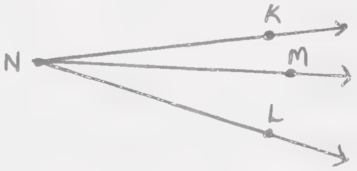
a) 90
b) greater than 90
c) 180
d) less than 90
e) unknown

11. A right triangle can be a (an) __?__ triangle?

a) equilateral
b) acute
c) obtuse
d) scalene
e) diagonol

12. Which ray is the common side of $\angle$ KNM and $\angle$MNL.

a) KN
b) KM
c) NM
d) NL
e) NK



13. Which word from the list expresses the following idea: "the study of sets of points?"

a) collinear
b) congruent
c) diameter
d) geometry
e) line

14. Which word from the list expresses the following idea: "disjoint planes?"
    - a) angle
    - b) endpoint
    - c) parallel
    - d) perpendicular
    - e) ray

15. Which symbol expresses the idea of intersection?
    - a) $\cup$
    - b) $\cong$
    - c) $\angle$
    - d) $\cap$
    - e) $\longrightarrow$

16. If the intersection of two lines that are in the same plans is the empty set, then the two lines __?__.
    - a) meet
    - b) are skew lines
    - c) are parallel
    - d) intersect
    - e) meet at a vertex

17. A triangle is the union of three __?__ determined by three noncollinear points.
    - a) rays
    - b) segments
    - c) lines
    - d) half-lines
    - e) scalenes

18. When 5,000,000 is written in scientific notation the answer is:
    - a) $5,000 \times 10^2$
    - b) $5,000 \times 10^3$
    - c) 500×10^3
    - d) 50×10^5
    - e) 5×10^6

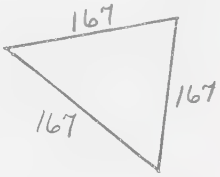
19. Which one of the following represents the associative property of addition?
    - a) $m(n+p) = mn+mp$
    - b) $(a+b)+c = a+(b+c)$
    - c) $x+y = y+x$
    - d) $(pq)r = p(qr)$
    - e) $rs = sr$

20. Counting numbers that have more than two factors are ___?___ numbers.

a) prime
b) twin prime
c) natural
d) composite
e) whole

21. Mr. Jones has a triangular field that is bounded by three highways. The length of each side of the field is 167 rods. What is the perimeter of this field in rods?

a) 3 x 167
b) 167 x 167
c) 167/3
d) 167-3
e) 167+3

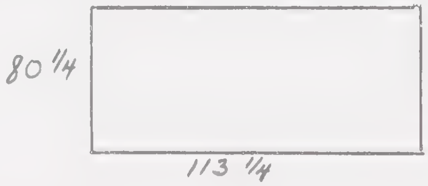


22. A pilot flew an airplane 2510 miles in 4 hours. He flew at an average speed of how many miles per hour?

a) 537.5
b) 627.5
c) 738.5
d) 728.5
e) 727.5

23. The rectangular floor of a certain convention room is 113 1/4 feet long and 80 1/4 feet wide. What is the area of the floor in square feet?

a) 113 1/4 / 80 1/4
b) 113 1/4 x 80 1/4
c) 113 x 80
d) 80 1/4
e) 113 1/4 x (80 1/4) /2



24. The shape of a field is square. The length of a side is 60 feet. What is the perimeter of this field in yards?

a) 240
b) 360
c) 400
d) 80
e) 20

25. In all, Bill walked less than 11 miles on Friday and Saturday together. He walked 5 miles farther on Saturday than on Friday. Which condition expresses the number of miles he could have walked each day?

a) $F+S<11 \wedge F+5=S$
b) $F+5<11 \wedge F+S>11$
c) $F=11+S$
d) $S+11=F$
e) $S+11=F-5$

26. Phil had \$5.17. He earned more money, but still had less than \$7.00. How much money had Phil earned? Choose the condition that expresses this.

    a) $n+\$7=5.17$
    b) $5.17+7=n$
    c) $5.17+n < 7$
    d) $7 < n-5.17$
    e) $5.17+n > 7$

27. One gallon of gasoline costs 38.5¢. At this rate, which condition expresses how much Mr. Carter had to pay for 14 gallons of gasoline?

    a) $38.5/14 = x/1$
    b) $38.5/x = 14/1$
    c) $38.5/1 = 14(x)$
    d) $38.5/1 = x/14$
    e) $38.5(x) = 14(1)$

28. Last week Mr. Smith drove .5 as many miles as Mr. Hayes. Mr. Hayes drove 128.5 miles last week. Which condition expresses how many miles Mr. Smith drove?

    a) $.5/1 = s/128.5$
    b) $.5(s)= 1(128.5)$
    c) $.5(1)= 5(128.5)$
    d) $.5/128 = s/1$
    e) $1/s = 128.5/.5$

29. Ellen needs at least 1 1.4 lb. of salted nuts for a party. The nuts she wants are sold only in 3/8 lb. cans. What is the fewest number of cans does Ellen have to buy?

    a) 2
    b) 3
    c) 4
    d) 5
    e) 6

30. Mr. Kenistion had 15 1/2 bushels of apples. He sold some, but not all, of these applies and then had less than 7 1/8 bushels left. Which condition expresses how many bushels of apples Mr. Kenistion sold?

    a) $15\ 1/2 + 7\ 1/8 < n$
    b) $15\ 1/2 \times 7\ 1/8 < n$
    c) $(15\ 1/2)\ /\ (7\ 1/8) < n$
    d) $(15\ 1/2) - n < 7\ 1/8$
    e) $(15\ 1/2)\ /\ n < 7\ 1/8$

MATHEMATICS ACHIEVEMENT TEST

WORK CAREFULLY. ALTHOUGH THERE IS MUCH READING IN THIS TEST THE ITEMS ARE FOR GRADE 6, 7 AND 8. TRY ALL ITEMS.

TIME: 1/2 hour

PART B

PROBLEM SOLVING

MATHEMATICS ACHIEVEMENT TEST

1. Suppose 'm' and 'n' represent two natural numbers. Which one of the following statements is not true? Note: Odd numbers = $\{1, 3, 5, ...\}$ Even numbers = $\{2, 4, 6, ...\}$

   a) If 'm' and 'n' are both even, then $\frac{m}{n}$ can be reduced to a lower fraction.

   b) If 'm' and 'n' are both odd, then $\frac{m}{n}$ can always be reduced to a lower fraction.

   c) If $\frac{m}{n} = \frac{3}{1}$, then 'm' is divisible by 'n', that is, there is zero for a remainder.

   d) If $\frac{m}{n} = \frac{2}{3}$, then m=2 and n=3.

   e) If $\frac{m}{n} = \frac{2}{3}$, then 3m=2n.

2. Given the set s = $\{1, 3, 5, ...\}$ of odd natural numbers, under which of the following operations is the set 'S' closed? That is, which operations when applied to any pair of elements of 'S' will yield only elements of 'S'?

   A) ADDITION B) MULTIPLICATION C) DIVISION

   The correct answer is:

   a) A and B only
   b) A and C only
   c) B and C only
   d) A only
   e) B only

3. Examine the following number sentences and discover the pattern. *SEE C), D) WHERE THE CIRCLED NUMBERS GIVE A HINT.

   A) $1+2 = \frac{2x3}{2}$ or 3

   B) $1+2+3 = \frac{3x4}{2}$ or 6

   C) $1+2+3+\textcircled{4} = \frac{\textcircled{4}x5}{\textcircled{2}}$ or 10

   D) $1+2+3+4+\textcircled{5} = \frac{\textcircled{5}x6}{\textcircled{2}}$ or 15

   Using this pattern find the sum of all the whole numbers between 1 and 15 (including 1 and 15). The sum is:

   a) 16
   b) 90
   c) 110
   d) 120
   e) 180

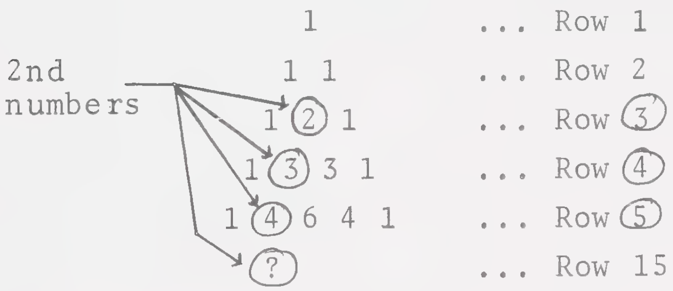
4. Decide which one of the following is not true. Three straight lines can be drawn in a plane so that there

   a) is no intersection point
   b) is one intersection point
   c) are two intersection points
   d) are three intersection points
   e) are four intersection points

5. John is thinking of two natural numbers where N = {1,2,3, ...}. One is smaller than 8 and the other is smaller than 9. Which one of the following statements can be correct?

   a) the sum of the two numbers can be greater than 15.
   b) the difference of the two numbers can be greater than 7.
   c) the product of the two numbers can be between 1 and 56.
   d) the sum of the two numbers can be less than 2.
   e) the product of the two numbers can be less than 1.

6. Examine the following number arrangement and answer the question below it.



   If the rows are continued in the same pattern, what will the second number be in the fifteenth row?

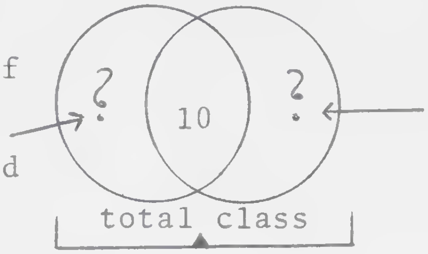
   a) 1
   b) 15
   c) 14
   d) 16
   e) 60

7. In his dresser John has 12 socks. He has 4 blue ones and 8 brown ones. If the room is dark and he cannot see, what is the minimum number of socks he must pull out to make certain he has two of the same color?

   a) 2
   b) 3
   c) 5
   d) 6
   e) 7

8. All the students in a certain class play either basketball or checkers. There are 14 students who play basketball; there are 16 students who play checkers; and there are 10 students who play both games. How many students are in the class?

a) 36
b) 40
c) 20
d) 18
e) 30



total of 14 when 10 is included

total of 16 when the 10 is included

9. Which fraction given below results in the largest number when the entire fraction is placed under a new numerator of one?

a) 1/2
b) (1/2 + 1.2)
c) (1/2 x 1/2)
d) (1/2 - 1/20)
e) 1/20

10. A father is nine times as old as his son. If the son is now 'n' years old, how old will the father be in 8 years?

a) 9n + 8 years
b) 9(n+8) years
c) n + 8 years
d) n + 9(8) years
e) 9n years

AN ATTITUDE TO MATHEMATICS SCALE

The best answer to each statement is your own first impression. There are no right or wrong answers. Think carefully, but do not spend too much time on any one question. Let your own personal experience guide you to choose the answer you feel about each statement. Please mark a response for every statement on the answer sheet provided.

1. I find most mathematics lessons:
    a) extremely interesting
    b) quite interesting
    c) interesting
    d) not very interesting
    e) not interesting at all

2. A knowledge of mathematics for any job at all is:
    a) most important
    b) very important
    c) quite important
    d) of small importance
    e) not important

3. If I did not have to take mathematics, I would like school:
    a) much less
    b) a little less
    c) same as now
    d) a little better
    e) much better

4. Mathematics is:
    a) the most important subject
    b) one of the more important subjects
    c) just as important as any other subject
    d) not as important as some of the other subjects
    e) the least important subject

5. I find problem solving:
    a) extremely interesting
    b) quite interesting
    c) interesting
    d) not very interesting
    e) not interesting at all

6. When I have difficulty with a new topic in my mathematics course, I ask my teacher to clarify the section:

   a) very frequently
   b) frequently
   c) sometimes
   d) hardly ever
   e) never

7. If books about mathematics were available, I would:

   a) read most of them
   b) read some of them
   c) look at the diagrams and pictures
   d) page through some of them
   e) never look at them

8. If someone says mathematics classes are worthless and a waste of time, I would:

   a) strongly disagree
   b) tend to disagree
   c) not take a side
   d) tend to agree
   e) strongly agree

9. When I do my homework, my mathematics is:

   a) always done first
   b) often done first
   c) usually done first
   d) sometimes done first
   e) never done first

10. I find mathematical puzzles:

    a) extremely interesting
    b) quite interesting
    c) sometimes interesting
    d) not very interesting
    e) not interesting at all

11. I would be interested in taking other subjects that make use of:

    a) a great deal of mathematics
    b) quite a bit of mathematics
    c) some mathematics
    d) a little mathematics
    e) no mathematics

12. If given the opportunity to join one of the following clubs, I would prefer a:
    a) mathematics club
    b) science club (Physics)
    c) science club (Chemistry)
    d) science club (Geology)
    e) literary club

13. If I could receive one of the following magazines for a year, I would pick:
    a) a mathematics magazine for high school students
    b) a magazine combining science and mathematics for high school sustents
    c) a science magazine for high school students
    d) a geology magazine for high school students
    e) a literary magazine for high school students

14. When I study my mathematics course, I most often:
    a) make written summaries of the sections covered
    b) do additional problem solving
    c) do many drill questions
    d) memorize the formulas given in the text
    e) look over some work done previously

15. If I listed my courses in order of preference, I would place mathematics:
    a) first
    b) second
    c) third
    d) fourth
    e) fifth

16. Whenever mathematical problems are presented to us for solving, I get:
    a) a great deal of satisfaction in working them out
    b) quite a bit of satisfaction in working them out
    c) some satisfaction in working them out
    d) very little satisfaction in working them out
    e) no satisfaction in working them out

17. My mathematics course has made:
    a) mathematics enjoyable for me
    b) mathematics a pleasant course
    c) me feel indifferent towards methematics
    d) mathematics classes an uncomfortable experience for me
    e) me strongly dislike mathematics

18. I feel my mathematics teacher:
    - a) enjoys teaching mathematics
    - b) gets some pleasure in teaching mathematics
    - c) gets some satisfaction in teaching mathematics
    - d) neither likes or dislikes teaching mathematics
    - e) dislikes teaching mathematics

19. When I do my mathematics homework, I am usually:
    - a) extremely interested
    - b) interested
    - c) somewhat interested
    - d) not too interested
    - e) not interested at all

20. When we start a new topic in mathematics, I am usually:
    - a) keenly interested
    - b) interested
    - c) somewhat interested
    - d) not too interested
    - e) not interested at all

21. The average amount of time I spend on homework assignment in math. takes the following time per day:
    - a) more than one hour
    - b) 3/4 hour to one hour
    - c) 1/2 hour to 3/4 hour
    - d) 1/4 hour to 1/2 hour
    - e) 0 hours to 1/4 hour

22. When I get an assignment in math.:
    - a) I do it immediately
    - b) I do it eventually
    - c) I may get it done
    - d) I put it off as long as possible
    - e) I don't do it

23. Most of my work in this class is done:
    - a) to satisfy my curiosity about math
    - b) to gain competence in math
    - c) to get a good mark
    - d) to just pass the class
    - e) to put in the time allotted to math

24. During mathematics lessons, I feel:
    - a) extremely confident in myself
    - b) quite confident in myself
    - c) confident in myself
    - d) a little unsure of myself
    - e) very unsure of myself

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